

EMISSIONS EVENTS MODELING ANALYSIS

Arkema, Inc. > Arkema Crosby Plant

Hurricane Harvey Vapor and Fire Events
August 29 - September 3, 2017

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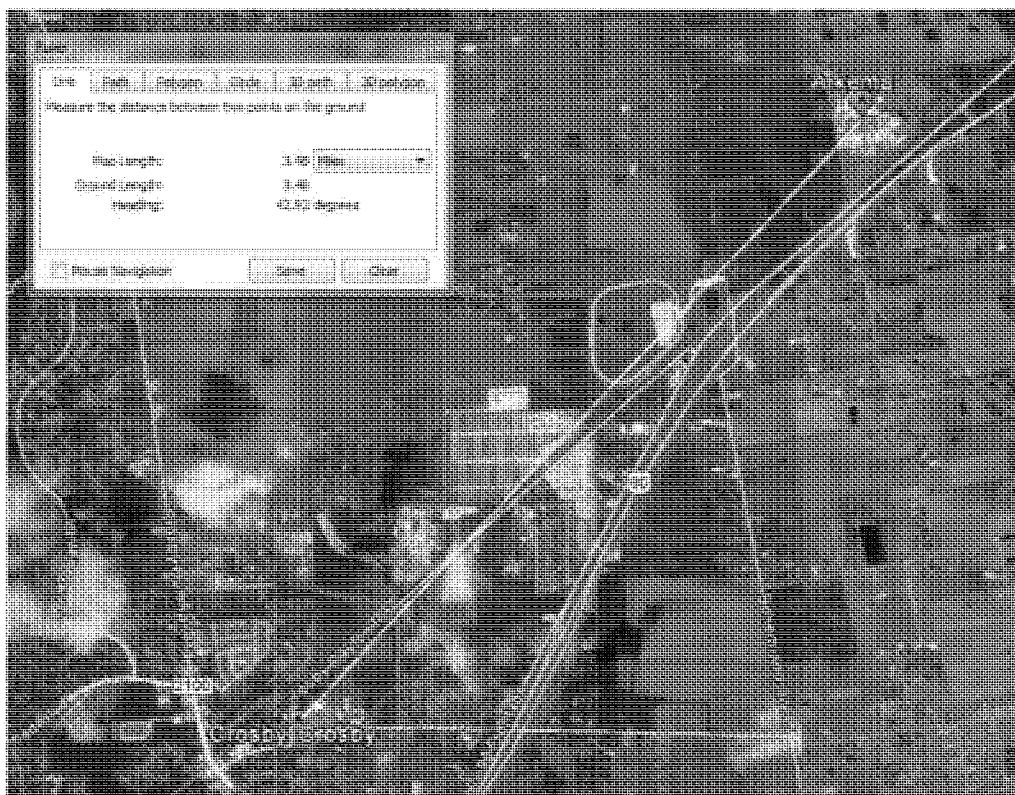
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1. EXECUTIVE SUMMARY

1.1. ARKEMA CROSBY PLANT DESCRIPTION AND HURRICANE HARVEY EVENT

Arkema Inc. (Arkema) owns and operates the Arkema Crosby Plant (Crosby Plant), located in Harris County, Texas. The facility is located at 18,000 Crosby Eastgate Road, 3.5 miles northeast of Crosby, Texas along U.S. 90. Figure 1-1 shows the location of the Crosby Plant.

Figure 1-1. Crosby Plant Location near Crosby, TX



Arkema is registered under Texas Commission on Environmental Quality (TCEQ) Customer Number (CN) 600124044. The Crosby Plant is registered under TCEQ Regulated Entity Number (RN) 100210301. The Crosby Plant operates under New Source Review (NSR) Permit No. 6271, Federal Operating Permit (Title V) No. 1554, and several registered and unregistered Permit by Rules (PBRs).

The plant produces liquid organic peroxides that are used primarily in the production of polystyrene, polyethylene, polypropylene, PVC and polyester reinforced fiberglass, and acrylic resins¹. Many of the liquid products are stored in stacked pallet-based small containers and must be refrigerated to maintain product stability.

¹ <http://www.arkema-america.com/en/arkema-america/united-states/crosby-tx/index.html>

On the night of August 25, Hurricane Harvey made landfall between Port O'Connor and Port Aransas, Texas as a major Category 4 hurricane. Harvey subsequently moved northeastward toward Houston and Harris County, ultimately becoming a tropical storm. While the winds associated with Harvey were substantially reduced after it came ashore, Harvey became stuck in a meteorological anomaly, hovering over the Houston and Southeast Texas areas for days, and depositing torrential rainfall in the area.

Arkema's Crosby Plant is located in a rural area of Harris County approximately 25 miles northeast of Houston. The Crosby Plant sat in the "bulls-eye" of Harvey's torrential downpours. Figure 1-2 shows the location of Hurricane Harvey in mid-afternoon on August 26, 2017.² The National Weather Service has reported that a rain gauge in the Cedar Bayou watershed, which includes the Crosby Plant, measured a total of 51.88 inches for the Harvey event, which marked a new record single rainfall event in the continental United States, and which exceeded the average *yearly* rainfall of 49.77 at George Bush Intercontinental Airport. The extreme rainfall associated with Hurricane Harvey resulted in unprecedented flooding within Harris County, the Cedar Bayou watershed, and the area around and including the Crosby Plant.

Figure 1-2. Hurricane Harvey August 26, 2017, 1455 Hours



² <https://www.youtube.com/watch?v=pRPlqK0CUD0>

The Crosby Plant has well-defined, standard operating procedures for the storage of organic peroxides at the facility. The plant's operating procedures include a hurricane preparedness plan and a Storage Building Limits and Safety Guidelines ("SBLSG") procedure, which includes guidelines concerning the use of refrigerated trailers in an emergency situation, such as where primary and secondary (backup) power is unavailable to the facility's refrigerated warehouses. During the extreme flooding caused by the Hurricane Harvey event, the rising floodwaters made it impossible for the plant to maintain primary power or emergency backup power, as well as to be able to deploy its liquid nitrogen emergency cooling system. All of the organic peroxide products requiring refrigeration ultimately had to be moved into refrigerated trailers. Eventually, however, even the refrigeration systems on these trailers failed, causing the organic peroxides inside them to slowly warm and begin to decompose. This decomposition and the fires that ultimately resulted were four of the five air emissions events reported at the Crosby Plant. The fifth emissions event was caused by overflow from two wastewater storage tanks at the facility. These emissions events are described in more detail in Section 2 of this report.

1.2. MODELING REPORT ORGANIZATION

Arkema filed separate initial and final incident reports online using the State of Texas Environmental Electronic Reporting System (STEERS) for each of the five emissions event incidents, which described the causes, actions, and reported release quantities. Arkema is submitting this modeling analysis in response to the TCEQ's September 26, 2017 request to provide air quality dispersion modeling of emissions associated with reportable emissions events (TCEQ Incident Nos. 266756, 266771, 266778, 267578, and 267679; Investigation No. 1438846) to evaluate the off-property air quality impacts due to the event releases. A copy of this September 26, 2017 request is included as Appendix A.

Consistent with the emissions event modeling checklist included with the TCEQ modeling request, this report contains the following information:³

- Project Overview;
 - Emissions event Descriptions
 - Constituents Evaluated
- Plot Plan and Area Map;
- Air Dispersion Modeling Description
 - Modeling Emissions Inventory
 - Stack Parameter Justifications
 - Models and Modeling Techniques
 - Dispersion Options;
 - Building Wake Effects (Downwash);
 - Receptor Grid;
 - Meteorological Data;
- Modeling Results;
- Monitored Background Concentration Data; and
- Electronic Files

The remainder of this report provides responses to all of TCEQ's requested information as well as the results of the dispersion modeling of each event and comparisons to applicable National Ambient Air Quality Standards (NAAQS), State Property Line Standards, benchmarks with which TCEQ is familiar (Effect Screening Levels [ESLs] and Air Monitoring Concentration Values [AMCVs]).

³ TCEQ Emissions Events Modeling Checklist dated December 2016.

2. PROJECT OVERVIEW

This section of the report contains a description of the emissions events reported by Arkema, a description of the emission calculation methodology for each event, and a discussion of the constituents and applicable air quality standards and benchmark levels evaluated in this analysis.

2.1. EMISSIONS EVENTS DESCRIPTIONS

Arkema reported five air emissions events that occurred at the Crosby Plant between August 29, 2017 and September 3, 2017 that were directly attributable to the record precipitation amounts associated with Hurricane Harvey.

Two types of emissions events took place resulting in five accidental releases caused by an Act of God and air emissions of chemicals associated with product and by-product streams. The first event was due to a rainfall-related overflow of an organic material from two waste water storage tanks. The other four emissions events that occurred were also due to flooding but were the result of the loss of refrigeration in trailers where containers of organic peroxide products were being temporarily stored. The products warmed and ultimately decomposed in an exothermic vaporization, and later ignited (i.e., as a result of heat generated in Events 2 and 3 or as a controlled ignition in Event 5) and burned along with the trailers themselves.

Each event is described in detail in the following subsections. The emission calculation methodology is provided in Section 2.2, and emission calculations are provided in Appendix B. Model inputs are included in Appendix C. A plot plan showing the location of each event is included in Section 3.

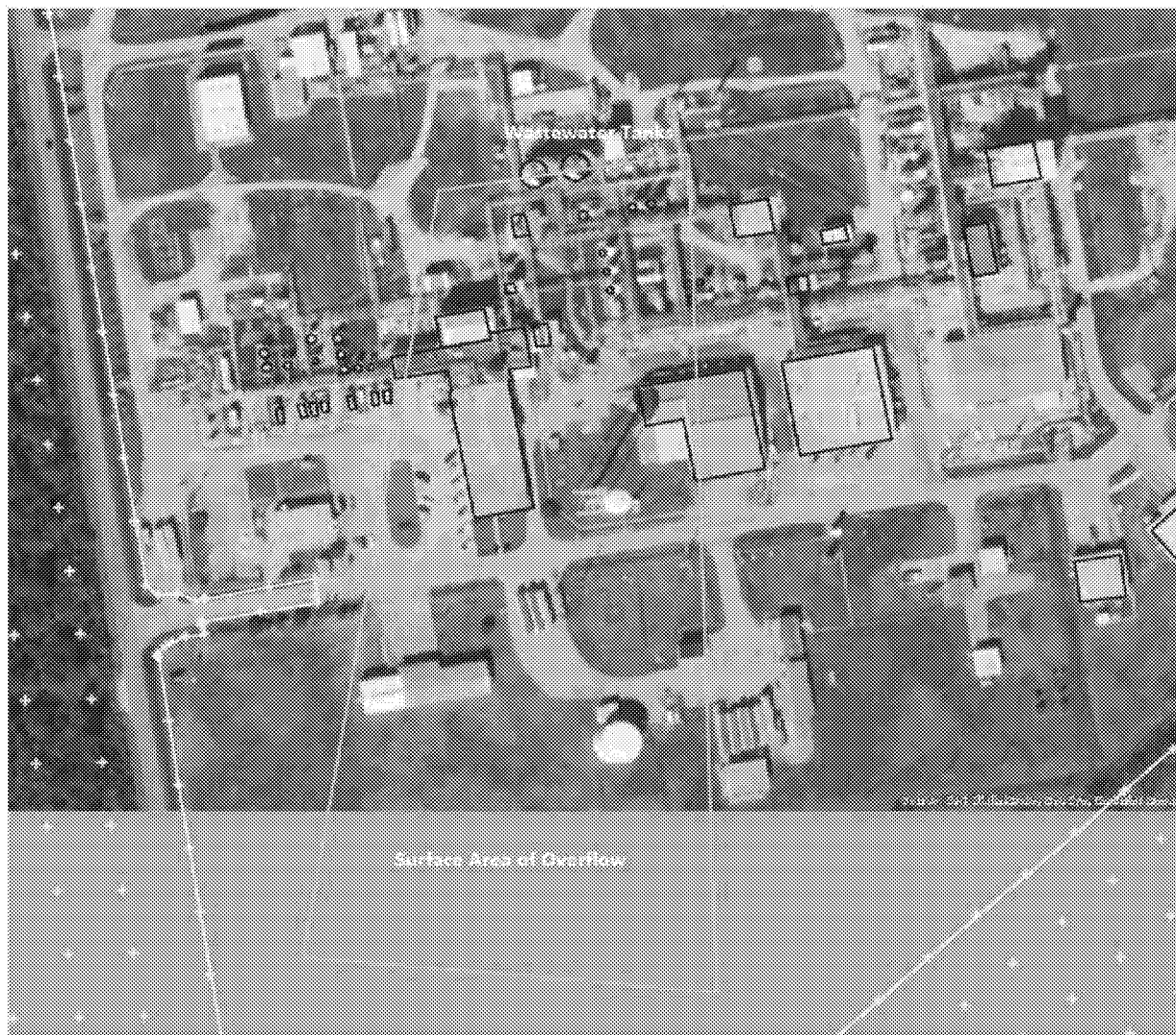
2.1.1. Event One (Incident Number 267578): Wastewater Tanks (14-T-2A/2B) Overflow

2.1.1.1. Description

The water levels in two waste water storage Tanks 14-T-2A and 14-T-2B at the Crosby Plant (Emission Point Number [EPN] WWTANKS) are usually maintained at around 50—60% of tank capacity, but they were drawn down well below their usual operating levels in preparation for the hurricane. During the event, as is normal practice and permitted under Underwater Injection Control (UIC) permits WDW1222 and WDW230, stormwater that fell on the process areas was pumped into the tanks, and in addition, rainwater fell directly into the tanks. Arkema continued to operate its disposal wells to draw down the tank levels during the event but over time, the injection rates could not keep up with the amount of water being pumped into the tanks from the process areas and the rainwater falling directly into the tanks. The operation of the disposal wells and the pumps in the process areas ceased altogether when power was no longer available at the site on the night of Sunday, August 27. After pumping ceased, the tanks continued to accumulate large amounts of rain water that fell directly into the tanks' open tops. The rainwater eventually caused both tanks to overflow through their overflow pipes into the tanks' secondary containment dike. At or around that time, however, the plant had accumulated a sufficient amount of floodwater to overtop the approximately four (4) foot containment dike around the tanks. This led to the release of the wastewater into the larger volume of floodwaters within the plant as shown in Figure 2-1.

Both tanks contained organic material that was lighter than water and thus floated at the surface of the tank contents. These organic layers, which consisted of residual organics and mineral spirits, are believed to comprise most of the material that overflowed during the event.

Figure 2-1. Event One Floodwaters Surface Area Location to South of Wastewater Tanks



2.1.1.2. Duration

The tanks overflowed on August 29, 2017, at approximately 12:00 hours. The end of the event is estimated to be 18:06 hours, which was the last recorded rainfall at the nearest weather station. Therefore, the duration of the event is estimated to be six (6) hours and six (6) minutes.

2.1.1.3. Emissions

The wastewater tanks overflow resulted in emissions of odorless mineral spirits, various volatile organic compounds (VOCs) that are listed in Section 2.2, water, and active oxygen from organic peroxides. Air emissions from this event resulted from evaporation of portions of the mineral spirits and residual organics from the

floodwaters, which were reported by the ride-out crew to have flowed toward the south fenceline of the Crosby Plant during the event.

2.1.2. Event Two (Incident Number 267679): Organic Peroxides Storage Trailer No. 1 Combustion

2.1.2.1. Description

Emissions Event 2 occurred after refrigeration was lost in refrigerated Trailer No. 1 located near Building No. 21. This led to organic peroxide product decomposition, ignition, a fire at the trailer, and an air emissions release. At this point, the plant had been evacuated for safety reasons upon the orders of the Unified Command, which consisted of the TCEQ, United States Environmental Protection Agency (U.S. EPA), Harris County Pollution Control Services Department, and others. As a result, the trailer and products were allowed to burn to completion. Figure 2-2 shows the location of Event 2 and Trailer No. 1.

Figure 2-2. Event 2 Trailer No. 1 Location near Building #21



2.1.2.2. Duration

The refrigerated trailer contents decomposed and emitted in a vapor stream at the rear of the trailer for approximately 30 minutes from 02:00-02:30 hours on August 31, 2017. At approximately 2:30 hours, the trailer contents and trailer ignited and burned from approximately 02:30-04:00 hours with the total emissions event estimated to have lasted two (2) hours.

2.1.2.3. Emissions

Emissions from this event resulted from decomposition of a portion of the products stored in the trailer and combustion of the remaining products, product packaging, and trailer components. The emissions from the event include: oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), PM with an aerodynamic diameter equal to or less than 10 micrometers (PM_{10}), PM with an aerodynamic diameter equal to or less than 2.5 micrometers ($\text{PM}_{2.5}$), hydrogen fluoride (HF), lead (Pb), and various VOCs that are listed in Section 2.2.

2.1.3. Event Three (Incident Number 266756): Organic Peroxides Storage Trailers Nos. 2-3 Combustion

2.1.3.1. Description

Emissions Event 3 occurred after refrigeration was lost in refrigerated Trailers Nos. 2 and 3, located near Building No. 27 as shown in Figure 2-3. Like emissions Event 2, this led to organic peroxide product decomposition, ignition, a fire at the trailers, and an air emissions release. Also like emissions Event 2, the trailer and products were allowed to burn to completion.

Figure 2-3. Event Three Trailers Nos. 2 and 3 Location near Building #27



2.1.3.2. Duration

The contents of two refrigerated trailers decomposed and emitted in a vapor stream at the rear of the trailers for approximately 30 minutes from 17:00-17:30 hours on September 1, 2017. At approximately 17:30 hours the trailers' contents and the trailers ignited and burned from approximately 17:30-19:00 hours with the total emissions event estimated to have lasted two (2) hours.

2.1.3.3. Emissions

Emissions from this event resulted from decomposition of a portion of the products stored in the trailers and combustion of remaining products, product packaging, and trailer components. The emissions from the event include: NO_x, CO, SO₂, PM, PM₁₀, PM_{2.5}, HF, Pb, and various VOCs that are listed in Section 2.2.

2.1.4. Event Four (Incident Number 266771): Organic Peroxides Storage Trailers Nos. 4-9 Product Decomposition

2.1.4.1. Description

Emissions Event 4 occurred after refrigeration was lost in six trailers (Nos. 4-9) located in the northeast portion of the plant site as shown in Figure 2-4. Like emissions Events 2 and 3, this led to organic peroxide product decomposition. However, unlike emissions Events 2 and 3, this decomposition did not lead to auto-ignition and no fire occurred during emissions Event 4.

Figure 2-4. Event Four and Five Trailers Nos. 4-9 Configuration



2.1.4.2. Duration

The product decomposition is estimated to have begun on September 2, 2017, at 14:17 hours, and continued for eleven (11) hours, ending at 1:17 hours on September 3, 2017.

2.1.4.3. Emissions

The peroxide decomposition resulted in emissions of various VOCs listed in Section 2.2 that are the known decomposition products of the types of organic peroxide products believed to have been stored in Trailer Nos. 4-9.

2.1.5. Event Five (Incident Number 266778): Organic Peroxides Storage Trailers Nos. 4-9 Combustion

2.1.5.1. Description

Emissions Event 5 occurred when the Unified Command and Arkema elected to cause a controlled ignition of the remaining six trailers (Nos. 4-9), which resulted in the initiation of a fire that was allowed to burn to completion.

2.1.5.2. Duration

The refrigerated trailers were ignited at 15:40 hours on September 3, 2017 and burned for a total of two (2) hours.

2.1.5.3. Emissions

Emissions from this event resulted from combustion of products stored in the trailer, product packaging and trailer components. The emissions from the event include: NO_x, CO, SO₂, PM, PM₁₀, PM_{2.5}, HF, Pb, and various VOCs that are listed in Section 2.2.

2.2. EMISSION CALCULATIONS

This section includes a description of the emission calculations performed for each emissions event. Detailed emission calculations were submitted to TCEQ on October 13, 2017, and an updated emissions summary including modeled emission rates is included in Appendix B to this report.

2.2.1. Event One (Incident Number 267578): Wastewater Tanks (14-T-2A/2B) Overflow

As explained in detail in Section 2.1.1.1, the loss of power and the accumulation of rainwater in the open tops of Tanks 14-T-2A and 14-T-2B resulted in the overflow of the organic layer in both tanks. When this material drained to the containment area around the tank, it mixed with the flood waters that breached the secondary containment from outside and flowed towards the south. Some amount of the organic material volatilized from the water, resulting in air emissions.

The amount of the organic layer that overflowed was estimated as follows:

- For Tank 14-T-2A, the tank organic layer was measured before and after the overflow. The volume of the overflow was calculated from the thickness of the organic layer and the tank diameter.
- For Tank 14-T-2B, organic layer thickness measurements were not available, however, an estimate of the volume of organics was based on the known typical waste water organics generation rate at the Crosby Plant.

The composition of the organic material is based on historical waste profiles.

For the emissions event originally reported into STEERS, Arkema conservatively assumed the entire quantity of the organic material released from the tanks volatilized to the atmosphere. Arkema also conservatively assumed that the entire quantity of the organic material released from the tanks was also released to the flood waters, i.e., none remained within the secondary containment basin. Based upon a more complete review of the event undertaken for this report, Arkema has revised the emissions estimates in order to more accurately represent estimated emissions associated with a relatively small organic release into a very large volume of flood waters. The updated emission calculations are included in this report and submitted to TCEQ under separate cover.

Emissions of the tank overflows were modeled using Toxchem™ Version 4.3 from Hydromantis Environmental Software Solutions, Inc. Toxchem utilizes fate and transport mechanisms for specific air contaminants into process-specific mass balance equations. Emissions from the tank overflow are modeled based on the quantity of organic material released to the flood waters. Emissions of air contaminants occur due to volatilization of contaminants from the air-water interface. The rate of volatilization is related to the contaminant concentration, vapor pressure, solubility, dimensions of wastewater process vessel, and environmental factors such as wind speed and temperature. All applicable Toxchem modeling files are included in Section 7 of this report.

The release area was represented as a lagoon with dimensions of 1.55 meters (m) deep, 100 m wide, and 400 m long extending from the wastewater tanks to the southern property line of the facility. Flood waters entered the lagoon area at an estimated rate of 1,097,862 gallons per minute (gpm) based on an estimated velocity of 1 mile per hour (mph) of flood waters moving across the site. Added to the flood waters were organics from the tank overflow at a rate of approximately 9.8 gpm for a resulting total flow of 1,097,872 gpm. The resulting mixture was modeled in Toxchem using ambient temperature and wind speed from the Wallisville Road C617 (EPA Site No. 48-201-0617) monitoring site. This approach defines the area of the emissions event and captures the maximum concentrations and highest emission rates from the release. Downstream of the defined area, the mixture concentration was very low, resulting in a much lower emission rate. Therefore, the calculation and modeling methodology utilized evaluates the highest emission rate on a pound per hour (lb/hr) basis. Table 2-1, below, lists the constituents emitted from the wastewater tank overflow air emissions event.

Table 2-1. Emissions Event One - Constituents Emitted

Constituent	CAS No.
T-Amyl Alcohol	75-85-4
T-Butyl Alcohol	75-65-0
Di-T-Butyl Peroxide	110-05-4
Di-T-Amyl Peroxide	10508-09-5
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	78-63-7
Ethyl Benzene	100-41-4
Naphthalene (Crude Or Refined)	91-20-3
1, 2, 4 - Trimethylbenzene	95-63-6
Hydrotreated Heavy Naphtha	64742-48-9
Mineral Spirits	--
Naphtha, light aromatic	64742-95-6
Xylene, mixed isomers	1330-20-7

2.2.2. Event Two (Incident Number 267679): Organic Peroxides Storage Trailer No. 1 Combustion

Emissions from Event 2 are calculated using mass balance, TCEQ guidance, and U.S. EPA AP-42 emission factors.

Emissions from the decomposition of organic peroxides stored in the trailers are based on the quantity of each organic peroxide product stored on the trailer, an estimate of the volume of peroxide that decomposed prior to combustion, and the amount of peroxide decomposition products combusted in the fire.

The combustion process is represented as a flare, and NO_x and CO emissions are calculated according to TCEQ guidance.⁴ Based on TCEQ guidance for combustion events that do not satisfy 40 CFR 60.18, a 93 percent (%) destruction efficiency (DRE) is assumed for peroxide decomposition products.⁵ Particulate matter emissions are calculated based on U.S. EPA AP-42 emission factors.⁶

Emissions from the combustion of the trailer, the containers storing the peroxide products, pallets, and the trailer refrigeration unit are based on U.S. EPA AP-42 emission factors.⁷ Emissions of HF are based on the composition and quantity of the refrigerant used in the refrigeration unit and a conservative assumption that all fluorine was converted to HF.

The battery in engine of the trailer refrigeration unit burned in the fire and emissions are represented as secondary lead processing in blast furnaces. Particulate and lead emission factors are based on AP-42 emission factors.⁸ Sulfur dioxide (SO₂) emissions from combustion of sulfuric acid in the battery are estimated assuming all sulfur from sulfuric acid is converted to SO₂. Note that since the original STEERS emissions event report was filed, emissions of HF and lead have been added based on information concerning the combustion of the refrigerated trailer components and battery, and a calculation error was corrected that had previously underestimated the quantity of organic peroxide combusted in the fire.

Emissions from diesel fuel stored in trailer fuel tanks are based on the estimated quantity of fuel stored and U.S. EPA AP-42 emission factors.⁹

⁴ TCEQ publication RG-360A/11, *Technical Supplement 4: Flares*, Table A-7, Air or Unassisted Flare, Low Btu (Revised January 2017).

⁵ TCEQ publication RG-360A/11, *Technical Supplement 4: Flares* (Revised February 2012).

⁶ U.S. EPA AP 42 Chapter 13.5, *Miscellaneous Sources – Industrial Flares*, Table 13.5-1: Heavily Smoking Flares (December 2016).

⁷ U.S. EPA AP-42 Chapter 2.5, *Solid Waste Disposal – Open Burning*, Table 2.5-1: Emission Factors for Open Burning of Municipal Refuse, factors for Automobile Components (October 1992).

⁸ U.S. EPA AP-42 Chapter 12.11, *Metallurgical Industry – Secondary Lead Processing*, Table 12.11-2: Emission Factors for Secondary Lead Processing (October 1986).

⁹ U.S. EPA AP-42, *External Combustion Sources – Fuel Oil Combustion*, Tables 1.3-1 and 1.3-2: No. 2 oil fired (1-01-005-01), (1-02-005-01), (1-03-005-01) for CO, NO_x, PM, PM₁₀, PM_{2.5}, and SO₂. Table 1.3-3 - Industrial boilers, Distillate oil fired (1-02-005-01/02/03) for VOC (May 2010).

Table 2-2. Emissions Event Two - Constituents Emitted

Constituent	CAS No.
Nonane	111-84-2
Nonene	124-11-8
OMS	68551-17-7
Acetone	67-64-1
Acetophenone	98-86-2
2-Ethyl hexanol	104-76-7
2-Ethyl hexanal	123-05-7
Ethane	74-84-0
Hydrofluoric Acid	7664-39-3
Lead	7439-92-1
CO	630-08-0
NO _x	10102-44-0
PM	--
PM ₁₀	--
PM _{2.5}	--
SO ₂	7446-09-5
Unclassified VOC	--

2.2.3. Event Three (Incident Number 266756): Organic Peroxides Storage Trailers Nos. 2-3 Combustion

Emissions from Event 3 are calculated using mass balance, TCEQ guidance, and U.S. EPA AP-42 emission factors.

Emissions from the decomposition of organic peroxides stored in the trailers are based on the quantity of each organic peroxide product stored on the trailer, an estimate of the volume of peroxide that decomposed prior to combustion, and the amount of peroxide decomposition products combusted in the fire.

The combustion process is represented as a flare, and NO_x and CO emissions are calculated according to TCEQ guidance.¹⁰ Based on TCEQ guidance for combustion events that do not satisfy 40 CFR 60.18, a 93 percent (%) destruction efficiency (DRE) is assumed for peroxide decomposition products.¹¹ Particulate matter emissions are calculated based on U.S. EPA AP-42 emission factors.¹²

Emissions from the combustion of the trailer, the containers storing the peroxide products, pallets, and the trailer refrigeration unit are based on U.S. EPA AP-42 emission factors.¹³ Emissions of HF are based on the

¹⁰ TCEQ publication RG-360A/11, *Technical Supplement 4: Flares*, Table A-7, Air or Unassisted Flare, Low Btu (Revised January 2017).

¹¹ TCEQ publication RG-360A/11, *Technical Supplement 4: Flares* (Revised February 2012).

¹² U.S. EPA AP 42 Chapter 13.5, *Miscellaneous Sources – Industrial Flares*, Table 13.5-1: Heavily Smoking Flares (December 2016).

¹³ U.S. EPA AP-42 Chapter 2.5, *Solid Waste Disposal – Open Burning*, Table 2.5-1: Emission Factors for Open Burning of Municipal Refuse, factors for Automobile Components (October 1992).

composition and quantity of the refrigerant used in the refrigeration unit and a conservative assumption that all fluorine was converted to HF.

The battery in engine of the trailer refrigeration unit burned in the fire and emissions are represented as secondary lead processing in blast furnaces. Particulate and lead emission factors are based on AP-42 emission factors.¹⁴ Sulfur dioxide (SO₂) emissions from combustion of sulfuric acid in the battery are estimated assuming all sulfur from sulfuric acid is converted to SO₂. Note that since the original STEERS emissions event report was filed, emissions of HF and lead have been added based on information concerning the combustion of the refrigerated trailer components and battery and a calculation error was corrected that had previously underestimated the quantity of organic peroxide combusted in the fire.

Emissions from diesel fuel stored in trailer fuel tanks are based on the estimated quantity of fuel stored and U.S. EPA AP-42 emission factors.¹⁵

Table 2-3. Emissions Event Three - Constituents Emitted

Constituent	CAS No.
Nonane	111-84-2
Nonene	124-11-8
OMS	68551-17-7
Acetone	67-64-1
Acetophenone	98-86-2
2-Ethyl hexanol	104-76-7
2-Ethyl hexanal	123-05-7
Ethane	74-84-0
Hydrofluoric Acid	7664-39-3
Lead	7439-92-1
CO	630-08-0
NO _x	10102-44-0
PM	--
PM ₁₀	--
PM _{2.5}	--
SO ₂	7446-09-5
Unclassified VOC	--

2.2.4. Event Four (Incident Number 266771): Organic Peroxides Storage Trailers Nos. 4-9 Product Decomposition

Emissions from Event 4 are calculated using mass balance. Emissions from organic peroxides stored on the trailers are based on the quantity of each organic peroxide product stored on the trailers, an estimate of the

¹⁴ U.S. EPA AP-42 Chapter 12.11, *Metallurgical Industry – Secondary Lead Processing*, Table 12.11-2: Emission Factors for Secondary Lead Processing (October 1986).

¹⁵ U.S. EPA AP-42, *External Combustion Sources – Fuel Oil Combustion*, Tables 1.3-1 and 1.3-2: No. 2 oil fired (1-01-005-01), (1-02-005-01), (1-03-005-01) for CO, NO_x, PM, PM₁₀, PM_{2.5}, and SO₂, Table 1.3-3 - Industrial boilers, Distillate oil fired (1-02-005-01/02/03) for VOC (May 2010).

volume of peroxide that decomposed, and the decomposition products known to be associated with those peroxide products.

Table Z-4. Emissions Event Four - Constituents Emitted

Constituent	CAS No.
Isobutane	75-28-5
Isobutene	115-11-7
Organic Mineral Solvent (OMS)	68551-17-7
Acetone	67-64-1

2.2.5. Event Five (Incident Number 266778): Organic Peroxides Storage Trailers Nos. 4-9 Combustion

Emissions from Event 5 are calculated using mass balance, TCEQ guidance, and U.S. EPA AP-42 emission factors.

Emissions from the decomposition of organic peroxides stored in the trailers are based on the quantity of each organic peroxide product stored in the trailer, an estimate of the volume of peroxide that decomposed prior to combustion, and the amount of peroxide decomposition products combusted in the fire. Note that since the original STEERS emissions event report was filed, a calculation error was corrected that had previously underestimated the quantity of organic peroxide combusted in the fire.

The combustion process is represented as a flare, and NO_x and CO emissions are calculated according to TCEQ guidance.¹⁶ Based on TCEQ guidance for combustion events that do not satisfy 40 CFR 60.18, a 93 percent (%) destruction efficiency (DRE) is assumed for peroxide decomposition products.¹⁷ Particulate matter emissions are calculated based on U.S. EPA AP-42 emission factors.¹⁸

Emissions from the combustion of the trailer, the containers storing the peroxide products, pallets, and the trailer refrigeration unit are based on U.S. EPA AP-42 emission factors.¹⁹ Emissions of HF are based on the composition and quantity of the refrigerant used in the refrigeration unit and a conservative assumption that all fluorine was converted to HF.

The battery in engine of the trailer refrigeration unit burned in the fire and emissions are represented as secondary lead processing in blast furnaces. Particulate and lead emission factors are based on AP-42 emission factors.²⁰ Sulfur dioxide (SO₂) emissions from combustion of sulfuric acid in the battery are estimated assuming all sulfur from sulfuric acid is converted to SO₂. Note that since the original STEERS emissions event report was filed, emissions of HF and lead have been added based on information concerning the combustion of the

¹⁶ TCEQ publication RG-360A/11, *Technical Supplement 4: Flares*, Table A-7, Air or Unassisted Flare, Low Btu (Revised January 2017).

¹⁷ TCEQ publication RG-360A/11, *Technical Supplement 4: Flares* (Revised February 2012).

¹⁸ U.S. EPA AP 42 Chapter 13.5, *Miscellaneous Sources – Industrial Flares*, Table 13.5-1: Heavily Smoking Flares (December 2016).

¹⁹ U.S. EPA AP-42 Chapter 2.5, *Solid Waste Disposal – Open Burning*, Table 2.5-1: Emission Factors for Open Burning of Municipal Refuse, factors for Automobile Components (October 1992).

²⁰ U.S. EPA AP-42 Chapter 12.11, *Metallurgical Industry – Secondary Lead Processing*, Table 12.11-2: Emission Factors for Secondary Lead Processing (October 1986).

refrigerated trailer components and battery, and a calculation error was corrected that had previously underestimated the quantity of organic peroxide combusted in the fire..

Trailers Nos. 4-9 were assumed to have consumed all in-tank diesel fuel prior to the fire.

Table 2-5. Emissions Event Five - Constituents Emitted

Constituent	CAS No.
Nonane	111-84-2
Nonene	124-11-8
Isobutane	75-28-5
Isobutene	115-11-7
n-propanol	71-23-8
n-propanal	123-38-6
sec-butanol	78-92-2
sec-butanone	78-93-3
OMS	68551-17-7
Acetone	67-64-1
Acetophenone	98-86-2
2-Ethyl hexanol	104-76-7
2-Ethyl hexanal	123-05-7
Ethane	74-84-0
Hydrofluoric Acid	7664-39-3
Lead	7439-92-1
CO	630-08-0
NO _x	10102-44-0
PM	--
PM ₁₀	--
PM _{2.5}	--
SO ₂	7446-09-5
Unclassified VOC	--

2.3. CONSTITUENTS EVALUATED AND APPLICABLE STANDARDS

Impacts from all speciated constituents described in Section 2.2 are compared to NAAQS, State Property Line Standards, AMCVs, or ESLs, as applicable. Each of these benchmarks is described below.

2.3.1. NAAQS

NAAQS have been established for nitrogen dioxide (NO₂), CO, SO₂, ozone, PM₁₀, PM_{2.5}, and Pb. For the purposes of this emissions event modeling, comparisons were made to the NAAQS standards for the constituents that were identified as being released in any or all of the five air emissions events. As all of the air emissions events were less than twelve (12) hours in length, comparisons are made to the short-term standards in all cases. Applicable NAAQS are summarized below in Table 2-6.

Table 2-6. Short-Term NAAQS for Criteria Air Pollutants

Pollutant	Averaging Period	Primary and Secondary NAAQS ($\mu\text{g}/\text{m}^3$)
CO	1-hour	40,000 (35 ppm) ¹
	8-hour	10,000 (9 ppm) ¹
NO ₂	1-hour	188 (100 ppb) ²
SO ₂	1-hour	196 (0.075 ppm)
	3-hour	1,300 (0.5 ppm) ¹
	24-hour	365 (0.14 ppm) ^{1,3}
PM ₁₀	24-hour	150 ⁶
PM _{2.5}	24-hour	35 ⁷
Pb	3-month ⁹	0.15

¹ Not to be exceeded more than once per calendar year.

² Interim SIL proposed in clarification memorandum from Mr. Tyler Fox to Regional Air Division Directors, *Applicability of Appendix W Modeling Guidance for the 1-hour NO₂ National Ambient Air Quality Standard*, June 28, 2010.

³ The 3-year average of the 98th percentile of the daily maximum 1-hour average.

⁴ Interim SIL proposed in clarification memorandum from Mr. Tyler Fox to Regional Air Division Directors, *Applicability of Appendix W Modeling Guidance for the 1-hour SO₂ National Ambient Air Quality Standard*, August 23, 2010.

⁵ U.S. EPA revoked the 24-hour and annual SO₂ NAAQS on June 2, 2010 (75 FR 33520, *Primary National Ambient Air Quality Standard for Sulfur Dioxide; Final Rule*). These standards remain in effect until one year after an area is designated for the 2010 standard.

⁶ Not to be exceeded more than three times in 3 consecutive years.

⁷ U.S. EPA promulgated PM_{2.5} SILs, Significant Monitoring Concentrations (SMCs), and PSD Increments on October 20, 2010 (75 FR 64864, *Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC); Final Rule*). The SILs and SMC became effective on December 20, 2010 (i.e., 60 days after the rule was published in the Federal Register) and the PSD Increments became effective on October 20, 2011 (i.e., one year after the date of promulgation). On January 22, 2013 the PM_{2.5} SILs were vacated/remanded and the SMC was vacated by the U.S. Court of Appeals for the District of Columbia Circuit.

⁸ The 3-year average of the 98th percentile.

⁹ Based on a 3-month rolling average.

2.3.2. State Property Line Standard

Title 30 of the Texas Administrative Code (30 TAC) Chapter 112, Control of Air Pollution from Sulfur Compounds specifies a State Property Line Standard for SO₂ as summarized below in Table 2-7.

Table 2-7. State Property Line Standards

Pollutant	Averaging Period	Standard ($\mu\text{g}/\text{m}^3$)
SO ₂	30-min ¹	715 ²

¹ Per TCEQ guidance, the modeled H1H concentration for the 1-hour averaging period is used to compare to the 30-minute SO₂ standard.

² Standard that is applicable to Harris County per TCEQ Air Quality Modeling Guidelines, APDG6232v2, Revised April 2015, Table B-3.

2.3.3. Health Effects Analysis

Air Monitoring Concentration Values (AMCVs) and Effect Screening Levels (ESLs) apply to emissions of speciated constituents. Modeled concentrations of these constituents are compared to AMCVs, if available. If no AMCV is available, the modeled concentrations are compared to ESLs.²³ As all of the air emissions events were less than twelve (12) hours in length, comparisons are made to the short-term AMCVs or ESLs in all cases. Speciated constituents emitted from the previously-summarized emissions events along with applicable AMCVs and ESLs are summarized below in Table 2-8. All short-term AMCVs and ESLs are based on a 1-hour averaging period.

²³ Based on information obtained during phone call between Mr. Matthew Korvar, TCEQ, and Mr. Curtis DeVore, Trinity Consultants, on October 9, 2017.

Table 2-8. AMCVs and ESLs

Constituent	CAS No.	ST AMCV ^{1,2} (µg/m ³)	ST ESL ^{1,3} (µg/m ³)
T-Amyl Alcohol	75-85-4	--	320
T-Butyl Alcohol	75-65-0	--	620
Di-T-Butyl Peroxide	110-05-4	--	100
Di-T-Amyl Peroxide	10508-09-5	--	100
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	78-63-7	--	100
Ethyl Benzene	100-41-4	86,000	26,000
Naphthalene (Crude Or Refined)	91-20-3	500	440
1, 2, 4 - Trimethylbenzene	95-63-6	15,000	4,400
Hydrotreated Heavy Naphtha	64742-48-9	--	3,000
2-Ethyl hexanal	123-05-7	--	1,400
2-Ethyl hexanol	104-76-7	--	540
Acetone	67-64-1	26,000	7,800
Acetophenone	98-86-2	--	490
Ethane ⁴	74-84-0	Simple Asphyxiant	Simple Asphyxiant
Isobutane	75-28-5	78,000	23,000
Isobutene	115-11-7	620,000	180,000
Nonane	111-84-2	16,000	4,800
Nonene	124-11-8	--	5,800
n-propanal	123-38-6	1,800	92
n-propanol	71-23-8	--	2,460
sec-butanol	78-92-2	--	3,000
sec-butanone	78-93-3	59,000	18,000
Hydrofluoric Acid ⁵	7664-39-3	--	3
Odorless Mineral Spirits (OMS)	68551-17-7	--	3,500
Naphtha, light aromatic	64742-95-6	--	4,400
Xylene, mixed isomers	1330-20-7	--	2,200

¹ Per the modeling request letter dated September 26, 2017 (including the Emissions Events Modeling Checklist dated December 2016), for health effects analyses, model results should be compared to the Air Monitoring Comparison Values (AMCVs), if available. Otherwise, model results should be compared to the applicable Effect Screening Levels (ESLs).

² The Short-Term (ST) AMCV is based on the 1-hour averaging period and is health-based. The AMCVs are obtained from the TCEQ Toxicity Factor Database

(<http://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome>) accessed on October 3, 2017.

³ The Short-Term (ST) ESL is based on the 1-hour averaging period and is health-based for all compounds except for the compounds where the odor based (T-Amyl Alcohol, Naphthalene, and n-propanal) or plant -based (HF) ESL is more restrictive. The ESLs are obtained from the TCEQ Toxicity Factor Database.

(<http://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=home.welcome>) accessed on October 2, 2017.

⁴ Simple asphyxiants do not need to be evaluated in health effects analyses.

⁵ The agricultural ESL is used for HF based on the land-use analysis performed in the area of the Crosby Plant.

3. AREA MAP, PLOT PLANS, AND MODELING SCHEMATICS

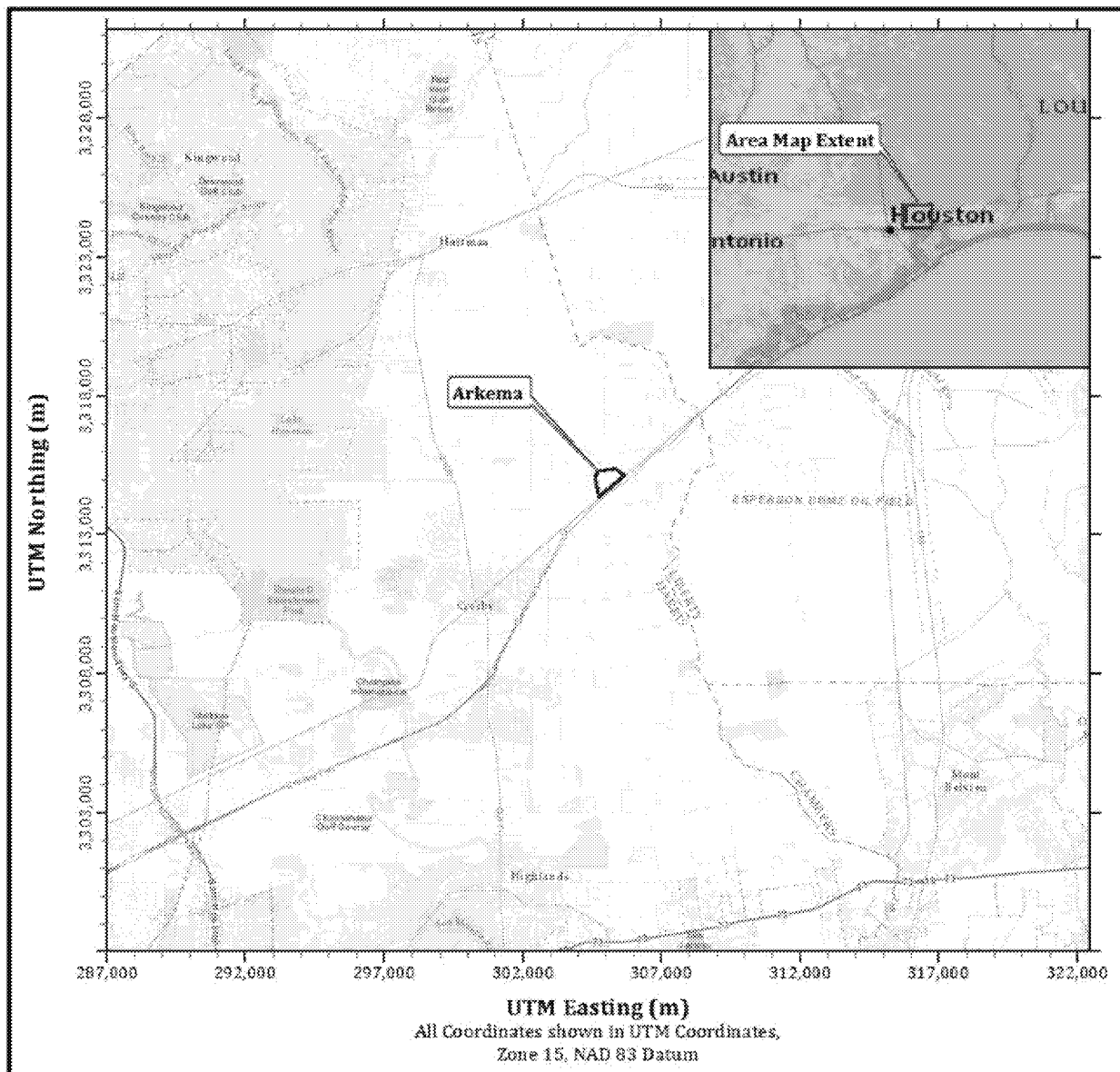
This section includes the figures described below. The coordinates in all figures are given in Universal Transverse Mercator (UTM) Zone 15 North American Datum 1983 (NAD83).

- Plot Plan – Figure 3-1
 - Depicts the location of the property line and the emission points evaluated in this analysis.
- Area Map – Figure 3-2
 - Depicts the property line as well as a visualization of the surrounding area and an inset to show the relative location of Crosby to Houston.
- Modeling Schematics – all modeling figures showing the model-depicted buildings, receptor grids, and land use information are in Section 4 of this report. Concentration plots are presented in Section 5 per event.

Figure 3-1. Arkema Crosby Plant Plot Plan



Figure 3-2. Arkema Crosby Plant Area Map



4. AIR DISPERSION MODELING DESCRIPTION

This section contains a description of the air dispersion modeling methodology performed as part of this analysis.

4.1. MODELING EMISSIONS INVENTORY AND SOURCE PARAMETER JUSTIFICATIONS

As described above in Section 2.1, five distinct air emissions events took place at the Hurricane Harvey-flooded Crosby Plant. Each event took place separately and did not overlap with other events in terms of emissions and potential impact on ambient air quality. To model these events, Arkema reviewed source types that are available in dispersion models and determined which options best represent each event, including the emissions transport and dispersion in the atmosphere. Each emissions event is described below along with the method of characterization that is used in the modeling analysis. For each event the total event-specific or sub-event-specific emissions described in Section 2 were assumed to be constant over the time period that the event took place. The total emissions were divided over the number of hours and minutes that event took place thus giving a mass per time used to prorate the unit emissions used in the modeling.

4.1.1. Event One, Incident 267578, Wastewater Tank Overflow Event

As described in Section 2.1.1, the rain associated with Hurricane Harvey caused an air emissions release associated with the wastewater tanks overflow that occurred on August 29, 2017 from 12:00 to 18:06 hours CDT (11:00 to 17:06 hours CST). The air release occurred when the heavy rains caused the two wastewater treatment tanks (Tank Nos. 14-T-2A and 14-T-2B) to fill and overflow. The overflow of wastewater containing mineral spirits and other facility wastes ran down the side of each open top tank via an overflow pipe and into the normally adequate containment area (area surrounding by berms). Because the containment area had already been breached by flood waters, the wastewater was released directly into the flood waters that flowed through the site. Thereafter, the flood waters rose sufficiently high that the train embankment to the south end of the plant was also breeched, and the waters drained slowly in that direction and the depth of water at the site slowly decreased.²²

To model this event, the overflow on the top of the flood waters are modeled as an area source as described below.

- 12:00 to 18:06 hours CDT – The two tanks overflowed and together resulted in dissolved-phase of mineral spirits and other materials in of the floodwaters surrounding the containment area.
 - With the train embankment located to the south and southeast being compromised and waters flowing out of the Crosby Plant, the impacted surface area of the flood waters are assumed to be to the south of the wastewater tanks.
 - The direction of flow is as indicated in Figure 4-1 and the size of the affected surface area is set to a 40,000 m² surface water plume as depicted in Figure 2-1.²³
 - This is modeled as an elevated area source at the approximate height of the flood water which was greater than the height of the containment berms, i.e., at 1.55 m above the ground surface.
 - The Source Identification in AERMOD is WSTWTROV.

²² Eyewitness observation by Arkema employee at the Crosby Plant on August 29, 2017.

²³ The surface area covered by the wastewater was a smaller area than that of the whole flooded area given the limited movement of the surface waters over most of the event duration.

Figure 4-1. Location and Direction of the Wastewater Spill in Event One



4.1.2. Event Two, Incident 267679, Storage Trailer No. 1 Burn Event

As described in Section 2.1.2, Emissions Event 2 occurred after refrigeration was lost in refrigerated Trailer No. 1, near Building 21, resulting in the organic peroxides to decompose, ignite, and burn the trailer contents and trailer structure. This event occurred on August 31, 2017, between 02:00 and 04:00 hours CDT (01:00 to 03:00 hours CST). Decomposition with associated releases in a vapor form took place in the first 30 minutes of the event. After decomposition, the materials ignited and the ensuing fire burned all materials and the trailer in approximately 90 minutes.

This event is represented by two slightly overlapping sources in terms of the timing of the events and the associated emissions:

- 02:00 to 02:30 hours CDT- The decomposition process after the loss of refrigeration in Trailer No. 1 takes place and a visible plume with limited plume rise emanating from the doors at the end of the trailer. This end is facing Building 21.
 - This vapor release is treated as a pseudo-point source (Source ID EV2TRLR) meaning that measured and assumed parameters are used to characterize the release diameter, temperature, and velocity.

- The release has hot gases (decomposition of organic peroxides is exothermic) at an estimated temperature of 792 Kelvin (K) (midpoint of the highest acceptable storage temperature of 310.9 K [100 degrees Fahrenheit (°F)] and its estimated flame temperature of 1,273 K (1,832 °F).²⁴
 - The release has a gas exit velocity of 1.16 m/s.²⁵
 - The release is assumed to fill the cavity of the trailer and then push open the trailer doors due to the built up pressure. The plume size at the base of the vapor plume was estimated at about 1.2 m (based on plume base puff observations in Event Three).
 - The height of release is the height of a typical trailer at 14 feet (ft) (4.27 m).²⁶
 - All decomposition emissions were assumed to be emitted in the 02:00 hour.
- 02:30 to 04:00 hours CDT – The combustion portion of this event is characterized as a hot pseudo-point source which is defined for purposes of this analysis as a source that is considered as a point source with a footprint of release set equal to the size of the area of the fire (at its full burn).
- The Trailer No. 1 fire is treated as a pseudo-point source (Source ID EV2FIRE).
 - The release is a fire with an estimated flame temperature of 1,273 K (1,832 °F).²⁷
 - The release has a gas exit velocity of 5.4 m/s.²⁸ See Section 4.2.3 for details.
 - The burn release is assumed to be over the width of the trailer and spilling out to a few meters on either side as the trailer and its contents were consumed. The pseudo-point source diameter was measured at approximately 8.24 m (based on the footprint of the trailer fire).
 - The height of release is taken as the average of the height of a typical trailer at 14 ft (4.27 m), which is the base height of the fire in its early stages and the ground at 0 ft, i.e., an average height of 7 ft (2.13 m).²⁹
 - Burn emissions took place in 1.5 hours, thus, event fire emissions were distributed over that time period.

4.1.3. Event Three, Incident 266756, Storage Trailers Nos. 2 and 3 Burn Event

As described in Section 2.1.3, Emissions Event 3 occurred after refrigeration was lost in refrigerated Trailers Nos. 2 and 3, near Building 27, resulting in the organic peroxides to decompose, ignite, and burn the trailer contents. This occurred on September 1, 2017, between 17:00 to 19:00 hours CDT (16:00 to 18:00 hours CST). Decomposition with associated releases in a vapor form took place in the first 30 minutes of the event. After that amount of decomposition, the materials ignited and the ensuing fire burned all materials and the trailer in about 90 minutes.

²⁴ AERSCREEN User's Guide, EPA-454/B-16-004, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 2016, pp 13.

²⁵ Based on an identified single puff change in height from one time step to another (calculation performed multiple times to confirm the plume rise) and scaled with known heights of nearby structures for the Event Three decomposing plume; Event Two was at night with no video coverage but the decomposition events were assumed to be similar. (<https://www.dallasnews.com/news/harvey/2017/09/01/large-fire-reported-flooded-chemical-plant-near-houston>)

²⁶ https://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/

²⁷ AERSCREEN User's Guide, EPA-454/B-16-004, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 2016, pp 13.

²⁸ Based on an identified single puff change in height from one time step to another (calculation performed multiple times to confirm the plume rise) and scaled with known heights of nearby structures for the Event Three fire plume; Event Two was at night with no video coverage but the burn events were assumed to be similar. (See Footnote 25 for video url).

²⁹ https://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/

This event is characterized by two slightly overlapping sources in terms of the timing of the event and the associated emissions. These will include:

- 17:00 to 17:30 hours CDT – The decomposition process after the loss of refrigeration in Trailers Nos. 2 and 3 takes place and two visible plumes with limited plume rise emanating from the end of the trailers.
 - These two trailer vapor releases are treated as two point sources (Source IDs EV3TRL2 and EV3TRL3).
 - Each release has hot gases (decomposition of organic peroxides is exothermic) at an estimated temperature of 792 K (midpoint of the highest acceptable storage temperature of 310.9 K [100 °F] and an estimated flame temperature of 1,273 K [1,832 °F]).³⁰
 - Each release has a gas exit velocity of 1.16 m/s.³¹
 - Each release is assumed to fill the cavities of the trailers and then push open the trailer doors due to the built up pressure. The plume size at the base of each one of the vapor plumes was measured at approximately 1.2 m (based on plume base puff observations).
 - The height of release is the height of a typical trailer at 14 ft (4.27 m).³²
 - All decomposition emissions were assumed to be emitted in the 17:00 hour and were equally divided between the two sources.
- 17:30 to 19:00 hours CDT – The combustion portion of this event is characterized as a combined (both trailers combined because they are so near each other) pseudo-point source which is defined for purposes of this analysis as a source that is considered as a point source with a footprint of release set equal to the size of the area of the fire (at its full burn).
 - The Trailers Nos. 2 and 3 fire is treated as a combined pseudo-point source (Source ID EV3FIRE)
 - The release is a fire with an estimated flame temperature of 1,273 K (1,832 °F).³³
 - The release has a gas exit velocity of 5.4 m/s.³⁴ See Section 4.2.3 for details.
 - The burn release is assumed to be over the combined widths of the two trailers and spilling out to a few meters on either side as the trailers and its contents were consumed. The pseudo-point source diameter of the two trailer fire was measured at 13.44 m (based on the combined footprint of the two-trailer fire).
 - The height of release is taken as the average of the height of a typical trailer at 14 ft (4.27 m) which is the base height of the fire in its early stages and the ground at 0 ft, i.e., an average height of 7 ft (2.13 m).³⁵
 - Burn emissions took place in 1.5 hours, thus, event fire emissions were distributed over that time period.

³⁰ AERSCREEN User's Guide, EPA-454/B-16-004, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 2016, pp 13.

³¹ Based on an identified single puff change in height from one time step to another (calculation performed multiple times to confirm the plume rise) and scaled with known heights of nearby structures for the Event Three decomposing plume. (See Footnote 25 for video url).

³² https://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/

³³ AERSCREEN User's Guide, EPA-454/B-16-004, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 2016, pp 13.

³⁴ Based on an identified single puff change in height from one time step to another (calculation performed multiple times to confirm the plume rise) and scaled with known heights of nearby structures for the Event 3 fire plume. (See Footnote 25 for video url).

³⁵ https://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/

4.1.4. Event Four, Incident 266771, Storage Trailers Nos. 4-9 Product Decomposition

As described in Section 2.1.4, Emissions Event 4 occurred after refrigeration was lost in the six Trailers Nos. 4-9, located in a vacant area within the Crosby Plant to the north of all major operations (with no structures other than the trailers nearby), resulting in the decomposition of the organic peroxides stored in trailers. This emissions event occurred on September 2, 2017 at 14:17 hours CDT (13:17 hours CST) and continued for 11 hours ending at 01:17 hours CDT (00:17 hours CST) on September 3, 2017. Only two of the trailers were observed to have decomposition products emitting from the rear doors of the trailers (Trailer No. 5 and Trailer No. 8) during the event.³⁶ This event is represented by two vapor plumes, one each from the rear doors of Trailers Nos. 5 and 8.

- 14:17 hours on September 2 to 01:17 hours on September 3 (a total of 11 hours) – The decomposition process after the loss of refrigeration in Trailers Nos. 4-9 takes place and two visible plumes with only limited plume rise emanate from the end of the trailers.
 - These two trailer vapor releases are treated as two point sources (Source IDs EV4TRL5 and EV4TRL8).
 - Each release has hot gases (decomposition of organic peroxides is exothermic) at an estimated temperature of 792 K (midpoint of the highest acceptable storage temperature of 310.9 K [100 °F] and its estimated flame temperature of 1,273 K [1,832 °F]).³⁷
 - Each release has a gas exit velocity of 1.16 m/s.³⁸
 - Each release is assumed to fill the cavities of the two trailers and then push open the trailer doors due to the built up pressure. The plume size at the base of each one of the vapor plumes was measured at about 1.2 m (based on plume base puff observations in Event Three as no useful video footage of this event were found).
 - The height of release is the height of a typical trailer at 14 ft (4.27 m).³⁹
 - All decomposition emissions were assumed to be emitted in this eleven hour time period and were equally divided between the two sources.

4.1.5. Event Five, Incident 266778, Storage Trailers Nos. 4-9 Controlled Burn Event

As described in Section 2.1.5, Emissions Event 5 occurred after refrigeration was lost in the six Trailers Nos. 4-9, located in a vacant area within the Crosby Plant to the north of all major operations (with no structures other than the trailers nearby), resulting in the decomposition of the organic peroxides represented in Event 4. Due to the instability of the products and as agreed to by TCEQ, U.S. EPA, Harris County Pollution Control, and Arkema, a controlled ignition and subsequent fire was initiated in all six trailers and allowed to burn to completion. The refrigerated trailers were ignited at 15:40 CDT on September 3, 2017 and burned for a total of two (2) hours (14:40 to 16:40 hours CST). The fire burned all stored materials and the trailer structures in about 120 minutes.

Due to the extreme heat and size of this fire as well as observed vertical plumes, this event is characterized by a large pseudo-point source.

- 15:40 to 17:40 hours CDT– This event is combustion of the six trailers and their contents. The event is characterized as three combined pseudo-point sources to account for the positions and distributions of the

³⁶ Eyewitness observation by Arkema employee at the Crosby Plant on September 3, 2017.

³⁷ AERSCREEN User's Guide, EPA-454/B-16-004, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 2016, pp 13.

³⁸ Based on an identified single puff change in height from one time step to another (calculation performed multiple times to confirm the plume rise) and scaled with known heights of nearby structures for the Event Three decomposing plume. Assumed to be similar to Event Four decomposition plumes. (See Footnote 25 for video url).

³⁹ https://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/

trailers. As seen in Figure 2-4, Trailers Nos. 4, 5, and 6 are located in a group to the east in the area. Trailer No. 7 is on a diagonal spaced from the other trailers, and Trailers Nos. 8-9 are positioned together to the west in the area. Thus, the trailer fires are combined in those groupings. Each pseudo-point source is defined as one of these groups with a footprint of release set equal to the size of the area around each group of trailers for the fire (at its full burn). The inputs are described below.

- Three groups of trailers are defined:
 - Trailers Nos. 4, 5, and 6 are treated as a combined pseudo-point source (Source ID EV5FIRE1).
 - Trailer No. 7 is treated as a pseudo-point source (Source ID EV5FIRE2).
 - Trailers Nos. 8 and 9 are treated as a combined pseudo-point source (Source ID EV5FIRE3).
- Each pseudo-point source has an estimated flame temperature of 1,273 K (1,832 °F).⁴⁰
- Each pseudo-point source has a gas exit velocity of 5.4 m/s.⁴¹ See Section 4.2.3 for details.
- Each pseudo-point source group of burning trailers is assigned a different combined diameter to represent its unique footprint which considered the footprint of the trailers as well as the nearby spillage of materials as the fires progressed from trailer-only to a disintegrating trailer on either side as the trailers and their contents were consumed. The pseudo-point diameter of the individual groups of trailer fires were:
 - Trailers Nos. 4, 5, and 6 diameter of 16.0 m.
 - Trailer No. 7 diameter of 8.2 m.
 - Trailers Nos. 8 and 9 diameter of 13.4 m.
- The height of release is taken as the average of the height of a typical trailer at 14 ft (4.27 m), which is the base height of the fire in its early stages and the ground at 0 ft, i.e., an average height of 7 ft (2.13 m).⁴²
- Burn emissions took place in 2.0 hours and were for the event total. Thus, the total event emissions were scaled by 50% to each hour and scaled again based on the number of trailers in each group. Thus:
 - Trailers Nos. 4, 5, and 6 at 50% of the total emissions distributed over two hours.
 - Trailer No. 7 at 16.7% of the total emissions distributed over two hours.
 - Trailers Nos. 8 and 9 at 33.3% of the total emissions distributed over two hours.
- Because of the overlap in whole hours (17:40 versus 17:00 for example), and due to the limitation of AERMOD only modeling full one hour time steps, the total event emission rate divided by the duration of the event (2 hours) was processed for each of the three hours of meteorology to be certain the meteorology and emissions were considered coincidentally. Thus, hours 1500-1600, 1600-1700, and 1700-1800 were all modeled to ensure conservativeness.

4.2. MODELS AND MODELING TECHNIQUES

4.2.1. Model Selection

A number of models were considered to perform this ambient impact assessment considering the nature of the event emissions releases, the required characterization of each (vapors, combustion, surface areas, etc.), the duration of the events, and commonly acceptable models for regulatory modeling. Some models may be applicable because of their prior use in emergency releases like U.S. EPA's Dense Gas Dispersion Model

⁴⁰ AERSCREEN User's Guide, EPA-454/B-16-004, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 2016, pp 13.

⁴¹ Based on an identified single puff change in height from one time step to another (calculation performed multiple times to confirm the plume rise) and scaled with known heights of nearby structures for the Event 3 fire plume. Assumed to be similar to the Event Five plume rise rates. (See Footnote 25 for video url).

⁴² https://ops.fhwa.dot.gov/freight/publications/size_regs_final_rpt/

(DEGADIS) and Lawrence Livermore's SLAB model, but both are designed for denser-than-air releases rather than the buoyant or neutrally buoyant plume releases that resulted from the Arkema emissions events. Arkema also considered more simplistic models (i.e. AERSCREEN) but determined that such models did not provide the refinement required. The current regulatory model, AERMOD, can handle many types of sources and was thought appropriate and representative of the Arkema sources.

Therefore, this air dispersion modeling analysis uses the AERMOD model in its most current version as released by U.S. EPA, Version 16216r which was released on January 17, 2017.^{43,44} U.S. EPA issued an update to its modeling guidance in the form of the *Guideline on Air Quality Models*, which was published on January 17, 2017 and reported via the U.S. EPA technical website.^{45,46}

4.2.2. Unit Emission Rate Modeling

Because the concentrations are directly proportional to the emissions in dispersion modeling, a unit emission rate of 1.0 g/s is used in all modeling. Where event emissions were only on a total per event basis and not differentiated between trailer vapor streams, fires, or groups of trailers, the unit emission is appropriately subdivided between the contributing sources as per a weighting related to the amount of material engaged in the event. For example, see the last bullet in Event 5 in Section 4.1.5 for a description of this distribution. Thereafter, the calculated emissions were assigned on a constituent by constituent basis using a spreadsheet to pro-rate the contributions and make the final concentration estimates per event and per chemical constituent.

4.2.3. Decomposition Vapor and Fire Plume Velocities

Because both the decomposition vapor and burning scenarios in Events 2 through 5 are associated with a rising plume from a pseudo-point source, the vertical rise was calculated using the relative height of individual puffs within each plume over a short duration of time. The technique that was used for either the vapor plume or the fire case was to observe video footage of the event with the most available footage, namely, Event Three which established that the decomposition events were similar as were the fires in terms of plume rise and observable smoke. The vertical rise was based on an identified single puff within the plumes and its change in height from one time step to another (calculation performed multiple times to confirm the vertical rise). To determine the heights of the puffs a side view of the plumes was determined and scaled with known heights of nearby structures.

As an example, the Event 3 vapor plume is presented in Figure 4-2 where the calculation of vertical rise was determined from the 4 m (13.1 ft) tracing of a puff over a time period of 3.44 seconds [s]] resulting in a vertical rise of 1.16 m/s (3.8 ft/s).

Likewise, the Event 3 fire plume was measured and the vertical velocity of the plume measured over a similar time step. Figure 4-3 shows this plume where the calculation of vertical rise was determined from the 10.9 m (35.7 ft) tracing of a puff over a time period of 2.0 seconds, resulting in a vertical rise of 5.4 m/s (17.8 ft/s). To determine if the vertical rise was representative of the shape and height of the plumes, the Event 3 fire was also modeled with a three dimensional receptor grid in AERMOD. Figure 4-4 shows the resulting plume which is a

⁴³ Stated by U.S. EPA to be part of the docket at Docket ID No. EPA-HQ-OAR-2015-0310 and available as of date of submittal of this protocol.

⁴⁴ Support Center for Regulatory Air Models, http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod

⁴⁵ *Appendix W to Part 51-Guideline on Air Quality Models*. Federal Register Vol 82 No. 10, January 17, 2017. pp. 5182-5235.

⁴⁶ Support Center for Regulatory Air Models, <http://www.epa.gov/ttn/scram/>

reasonable representation of the actual Event 3 fire plume. The orientation of both Figures 4-3 and 4-4 are looking north.

Figure 4-2. Event Three Decomposition Plume^a

* Figure 4-2 measurements are in Adobe inches and were scaled to feet using the scaled height of the trailers at 14 ft resulting in a scalar of 9 ft/Inch.

Figure 4-3. Event Three Fire Plume Looking North

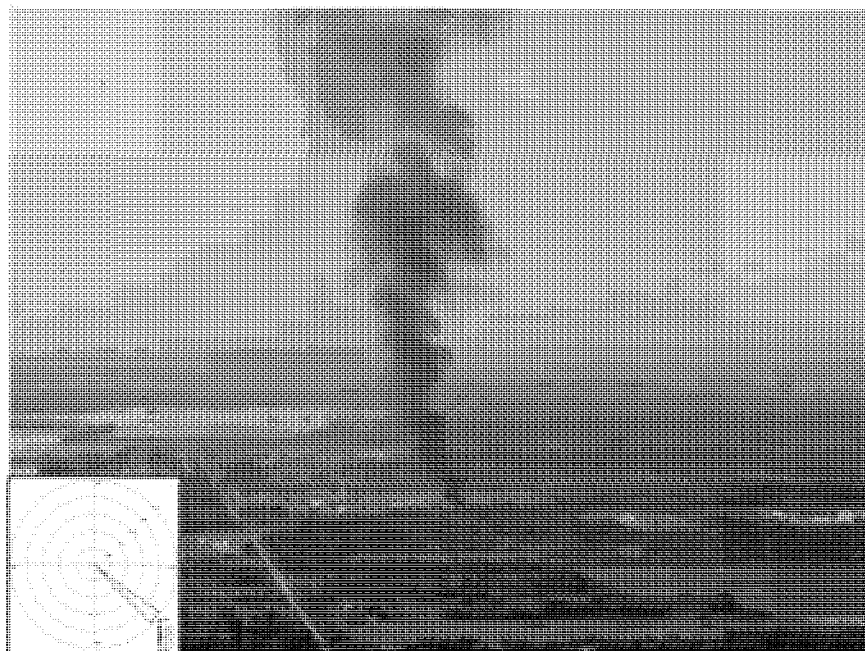
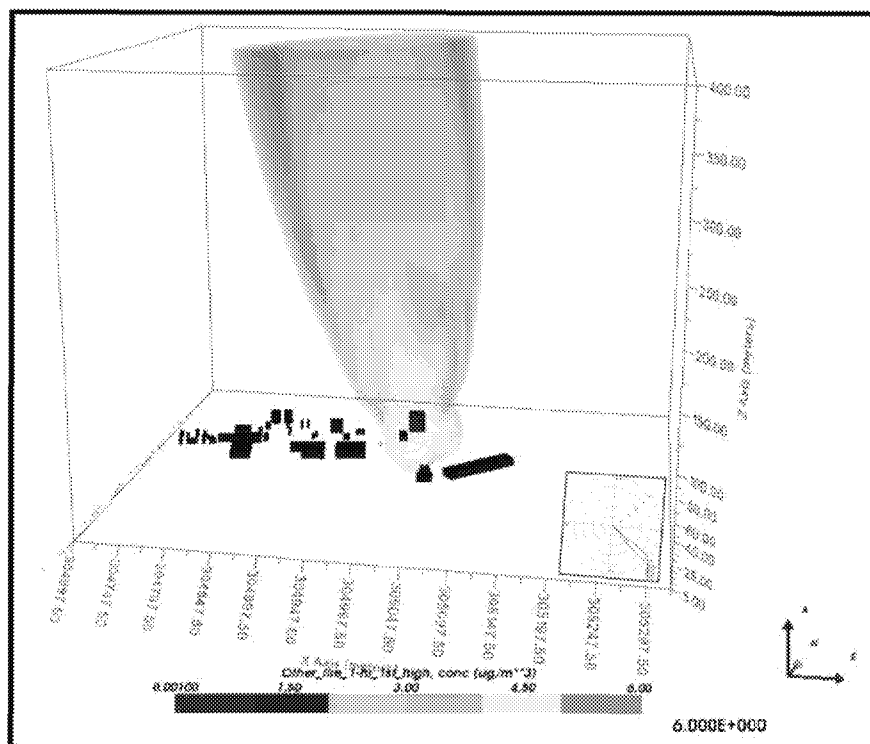


Figure 4-4. Event Three Fire Plume 3D Modeling Results Looking North



4.2.4. Coordinate System

The locations of emission sources, structures, and receptors are represented in the appropriate zone of the Universal Transverse Mercator (UTM) coordinate system using the North American Datum 1983 (NAD83). The Crosby plant and all modeled receptors are located in UTM Zone 15.

4.2.5. Terrain

The terrain elevations for each receptor, downwash structure, and emissions source were determined using United States Geological Survey (USGS) 1/3 arc-second National Elevation Data (NED). The NED, obtained from the USGS, provides terrain elevations at approximately 10 meter resolution.⁴⁷ The AERMOD terrain processor, AERMAP (version 11103), was used to assign the interpolated terrain height for each source, receptor and structure included in the model.

In addition, the NED elevation files were used in AERMAP to compute the hill height scales associated with each receptor. While seeming to be an irrelevant calculation for the area around the plant which has very little elevation change (in the 14-16m range across most of the area), the computation was nonetheless enabled to allow the AERMOD model to best determine the effects that any elevated terrain would have on the source plumes. AERMAP searched all nearby elevation points for the terrain height and location that has the greatest influence on each receptor (generally the highest point in the area) and uses that to determine the hill height scale for each receptor. AERMOD then uses the hill height scale in order to select the point where a plume may divide between going around a terrain feature and lofting over the feature. Very few terrain features are noted in the Crosby Plant area but elevations were included, nonetheless.

4.3. DISPERSION OPTIONS

In order to determine whether the urban or rural dispersion option was appropriate for the Crosby Plant emissions event modeling, Arkema characterized the land use surrounding the Crosby Plant. This data is important in determining the applicable boundary layer characteristics that affect a model's calculation of ambient concentrations.

The method used to determine the urban or rural status of the area around Arkema is called the "land use" technique because it examines the various land uses within three (3) kilometers (km) of the Crosby Plant and quantifies the percentage of area in various land use categories. In the land use method, the land use within a 3 km radius of the Crosby Plant was analyzed using the land use scheme described by Auer (1978)⁴⁸. Using this methodology, the Crosby Plant would be considered urban if the Table 4-1 land use types I1, I2, C1, R2, and R3 were 50 percent or more of the area within the 3 km circle, otherwise it would be rural. Following this guidance, 2011 land use data (most recent available) were obtained from the USGS through ArcGIS, and a three (3) km radius circle inscribed electronically around the Crosby Plant.⁴⁹ All data were georeferenced and tabulated using the categories shown in Table 4-1 for urban and rural designation.

Figure 4-5 shows the layout of the land use where greens, yellows and browns are farmland, forests, and grasses, pinks are non-urban developed lands, and red and dark red are urban areas. Table 4-2 shows the results of this land categorization process. As can be seen, the area is predominantly rural by an overwhelming margin.

⁴⁷ <http://www.mrlc.gov/viewerjs/>

⁴⁸ Auer, Jr., A.H., Correlation of Land Use and cover with Meteorological Anomalies, *Journal of Applied Meteorology*, 17(5), pp 636-643, 1978.

⁴⁹ <http://www.mrlc.gov/viewerjs/>

at 95.5 percent. Therefore, the AERMOD air dispersion modeling included in this analysis uses rural dispersion options.

Table 4-1. 2011 NLCD Categories Vs. Auer Urban / Rural Categories

2011 NLCD Land Cover Classification		Auer Land-Use Classification		Rural or Urban
11	Open Water	A5	Water Surfaces	Rural
12	Perennial Ice/Snow	A5	Water Surfaces	Rural
21	Developed, Open Space	A1	Metropolitan Natural	Rural
22	Developed, Low Intensity	R1	Common Residential	Rural
23	Developed, Medium Intensity	I1, I2, C1, R2, R3	Industrial/Commercial/Compact Residential	Urban
24	Developed, High Intensity	I1, I2, C1, R2, R3	Industrial/Commercial/Compact Residential	Urban
31	Barren Land	A3	Undeveloped (Grasses/Shrub)	Rural
41	Deciduous Forest	A4	Undeveloped (Wooded)	Rural
42	Evergreen Forest	A4	Undeveloped (Wooded)	Rural
43	Mixed Forest	A4	Undeveloped (Wooded)	Rural
52	Shrub/Scrub	A3	Undeveloped (Grasses/Shrub)	Rural
71	Grassland/Herbaceous	A3	Undeveloped (Grasses/Shrub)	Rural
81	Pasture/Hay	A2	Agricultural	Rural
82	Cultivated Crops	A2	Agricultural	Rural
90	Woody Wetlands	A4	Undeveloped (Wooded)	Rural
95	Emergent Herbaceous Wetlands	A3	Undeveloped (Grasses/Shrub)	Rural

Figure 4-5. Distribution of Land Use within 3 km of the Crosby Plant

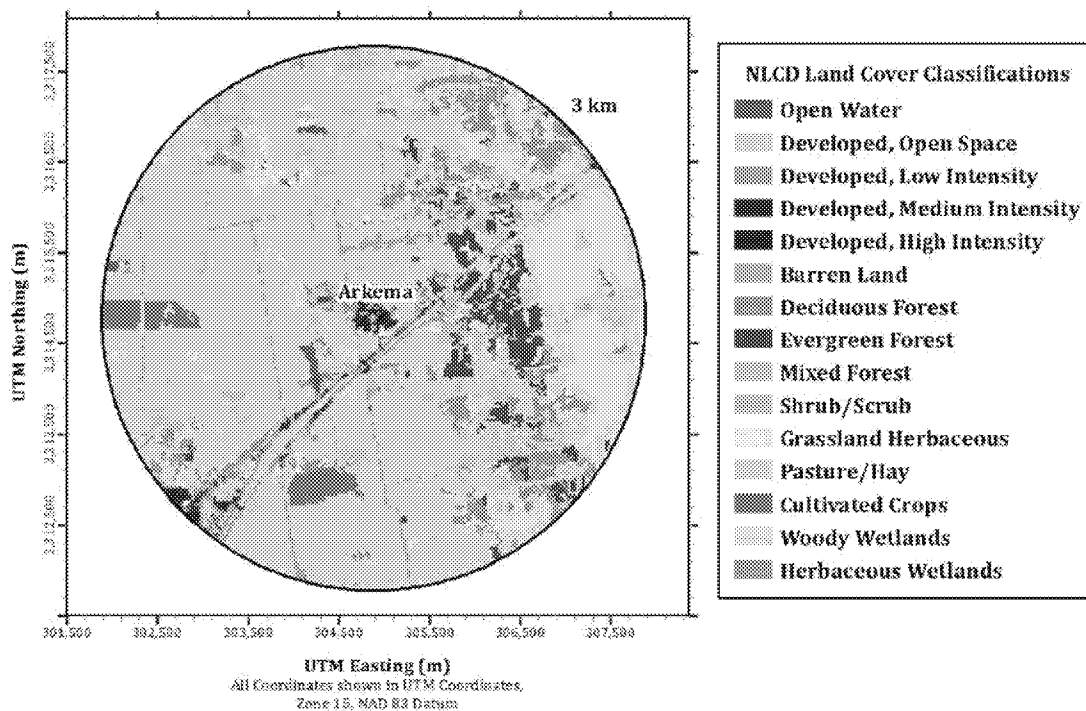


Table 4-2. Crosby Plant Urban/Rural Determination

<i>Percent Land Categorization ArcGIS Analysis Results for Arkema</i>		
Category ID	Category Description	Percent
11	Open Water	0.4%
21	Developed, Open Space	6.5%
22	Developed, Low Intensity	3.5%
23	Developed, Medium Intensity	0.7%
24	Developed, High Intensity	0.4%
31	Barren Land	0.0%
41	Deciduous Forest	6.1%
42	Evergreen Forest	3.6%
43	Mixed Forest	4.4%
52	Shrub/Scrub	3.4%
71	Grassland/Herbaceous	1.5%
81	Pasture/Hay	50.1%
82	Cultivated Crops	1.8%
90	Woody Wetlands	17.2%
95	Emergent Herbaceous Wetlands	0.5%
Total		100%
Urban		4.5%
Rural		95.5%

4.4. BUILDING WAKE EFFECTS (DOWNWASH)

The purpose of a building downwash analysis is to determine if the plume discharged from one of the vapor releases is influenced by the turbulent wake of any onsite buildings or other structures including the trailers themselves, resulting in downwash of the plume. The downwash of the plume can result in elevated ground-level concentrations in the near wake of a building and is required for consideration in the modeling.

The U.S. EPA's Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) (version 04274), are used to account for building downwash influences on the decomposition vapor releases in Events 2, 3, and 4. No downwash is included for the combustion events modeling given the high heat of release and little video evidence suggesting that building downwash influences should be considered.

Table 4-2 shows a summary of all downwash structures included in the modeling analyses, excluding the trailers which were added to each scenario as appropriate and as shown in Figures 2-2 through 2-4. Each trailer is assigned typical dimensions of 53 ft length (16.15 m), 8.53 ft width (2.6 m), and 14 ft high (4.27 m). The trailers were added to each event where appropriate because the video evidence showed that the trailers acted as downwash structures during the decomposition phase of the events.

Table 4-3. Downwash Structures Included in Crosby Plant Event Modeling Except Trailers ¹

Building or Structure ID	Anchor Coordinate, m		Base Elevation, m	Structure Height, m
	East	North		
BLDG16	304913.1	3314791.4	15.66	5.80
WW1	304816.9	3314869.84	15.57	12.20
WW2	304833.1	3314872.54	15.59	12.20
BLDG10	304857.1	3314781.7	15.5	5.80
BLDG28	304807.9	3314848	15.63	4.57
17B	304836	3314850.13	15.52	3.70
17C	304855.1	3314853.02	15.61	7.60
17D	304862.3	3314854.57	15.65	7.60
17T26	304843.5	3314835.02	15.51	5.20
17T24	304845	3314827.72	15.53	5.20
17T22	304846.5	3314820.42	15.55	5.22
17T37	304876.8	3314823.12	15.64	3.07
17T39	304881.3	3314823.62	15.65	5.18
17T28	304878.1	3314817.06	15.63	3.05
BLDG17	304892.5	3314852.2	15.65	10.60
BLDG18	304914.9	3314824.1	15.66	4.00
BLDG34	304927.9	3314842.6	15.61	4.90
BLDG24	304805.6	3314821.6	15.6	7.32
BLDG15	304816.6	3314805.5	15.52	5.49
4T76STK	304712.5	3314796.76	15.48	6.10
4T73STK	304713.6	3314791.07	15.44	4.57
4T55STK	304721.6	3314791.56	15.43	5.18
4T49STK	304732.4	3314793.09	15.48	6.10
4T61STK	304730.7	3314802.19	15.55	6.71
4T66STK	304741.1	3314802.47	15.58	5.49
4T67A	304742.2	3314796.1	15.55	5.49
4T77STK	304748.9	3314790.58	15.57	4.57
4T675	304743.4	3314790.27	15.53	5.49
4T77STK2	304753.8	3314790.69	15.59	3.96
4T43STK	304759.2	3314775.6	15.52	5.20
4T32STK	304757.2	3314775.1	15.54	5.20
4T30STK	304748.3	3314773.6	15.53	5.20
4T37STK	304737.9	3314772.3	15.41	5.00
4T29STK	304733.4	3314771.1	15.36	5.00
4T28STK	304729.1	3314770.4	15.33	5.00
4T27STK	304720.2	3314767.9	15.33	5.00
BLDG4A	304781.2	3314797	15.53	11.60
BLDG4B	304793.8	3314731	15.4	5.80
BLDG30	304992.1	3314874	15.95	17.70
BLDG32	304983.3	3314844.2	15.95	4.90
BLDG21	305056.1	3314726.3	15.64	6.60
BLDG27	305026.5	3314714.4	15.54	4.35
BLDG	304976.6	3314799.1	15.54	6.60

¹ Trailers were included per event as required to be representative of the event.

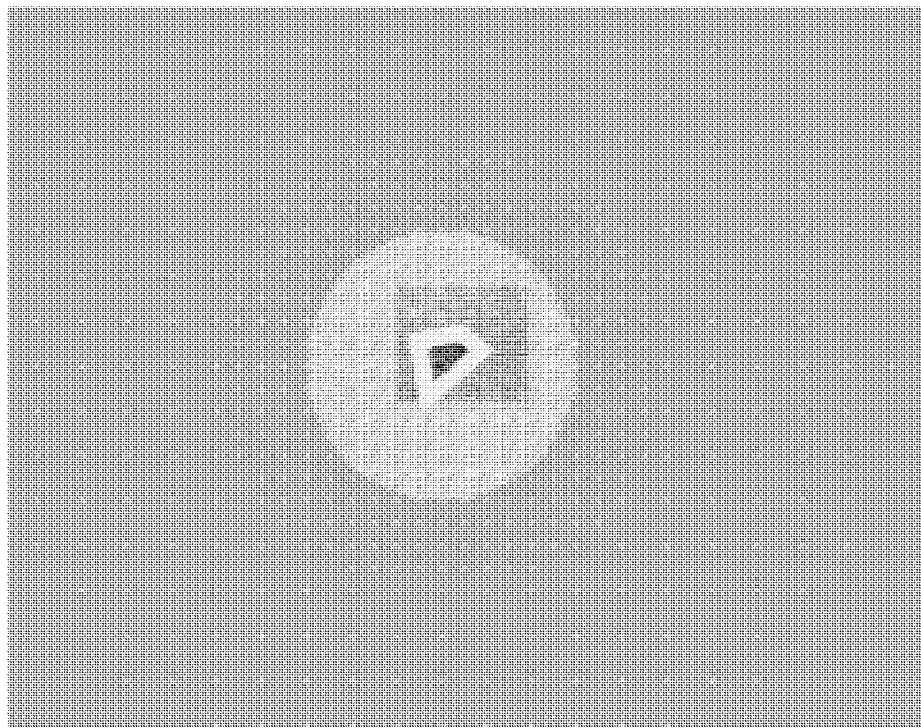
4.5. RECEPTOR GRID

The receptor grids included in the air dispersion modeling for each emissions event follow the most recent TCEQ modeling guidance, which meets or exceeds the receptor grid requirements outlined in the emissions event modeling request letter.^{50,51} Each modeling analysis includes a series of nested receptor grids as described below:

- **Tight receptors:** 25 m spacing around the fence line and including receptors out to 250 m beyond the fence line;
- **Fine receptors:** 100 m spacing from 250 m to 1,000 m beyond the fence line;
- **Medium receptors:** 500 m spacing from 1,000 m to 5,000 m beyond the fence line; and
- **Coarse receptors:** 1,000 m spacing from 5,000 m to 10,000 m beyond the fence line.

Figure 4-6 and Figure 4-7 show the full receptor grid used in the modeling as well as the innermost receptors of the grid near the Crosby Plant, respectively.

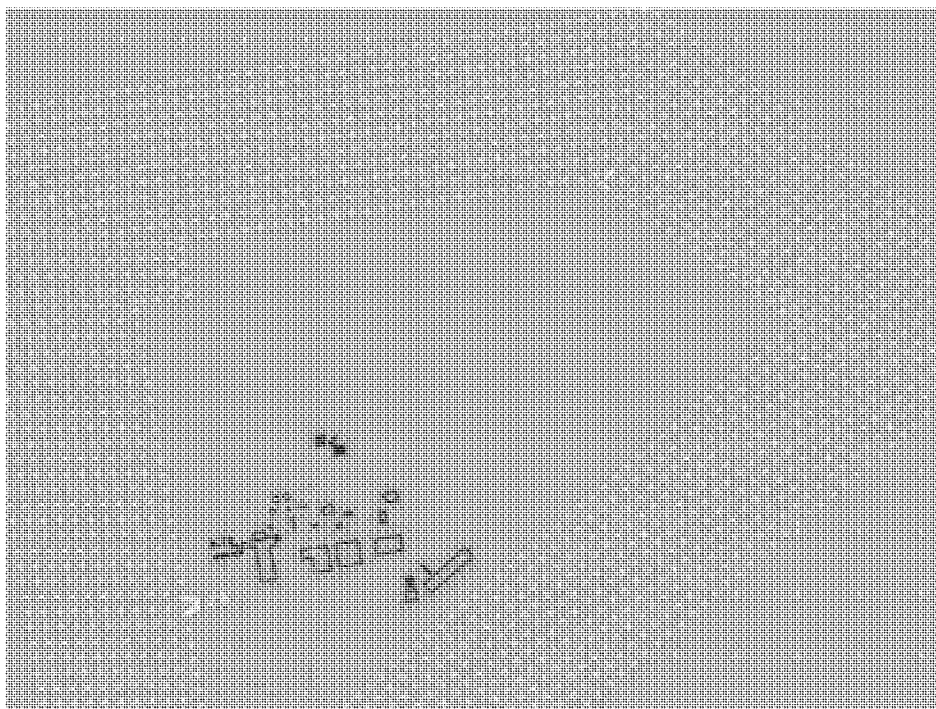
Figure 4-6. Full Modeling Receptor Grid for the Crosby Plant



⁵⁰ Air Quality Modeling Guideline, APDG 6232, Air Permits Division, Texas Commission on Environmental Quality, Austin, Texas, April 2015.

⁵¹ Emissions event modeling request letter dated September 26, 2017, from Ms. Warda Omar, TCEQ Houston Region, to Mr. Leslie Comardelle, Arkema, and TCEQ Emissions Events Modeling Checklist dated December 2016.

Figure 4-7. Innermost Portion of the Modeling Grid for the Crosby Plant



4.6. METEOROLOGICAL DATA

Meteorological data was required as input to the AERMOD model to allow the characterization of the transport and dispersion of the emissions associated with each emissions event at the Crosby Plant.

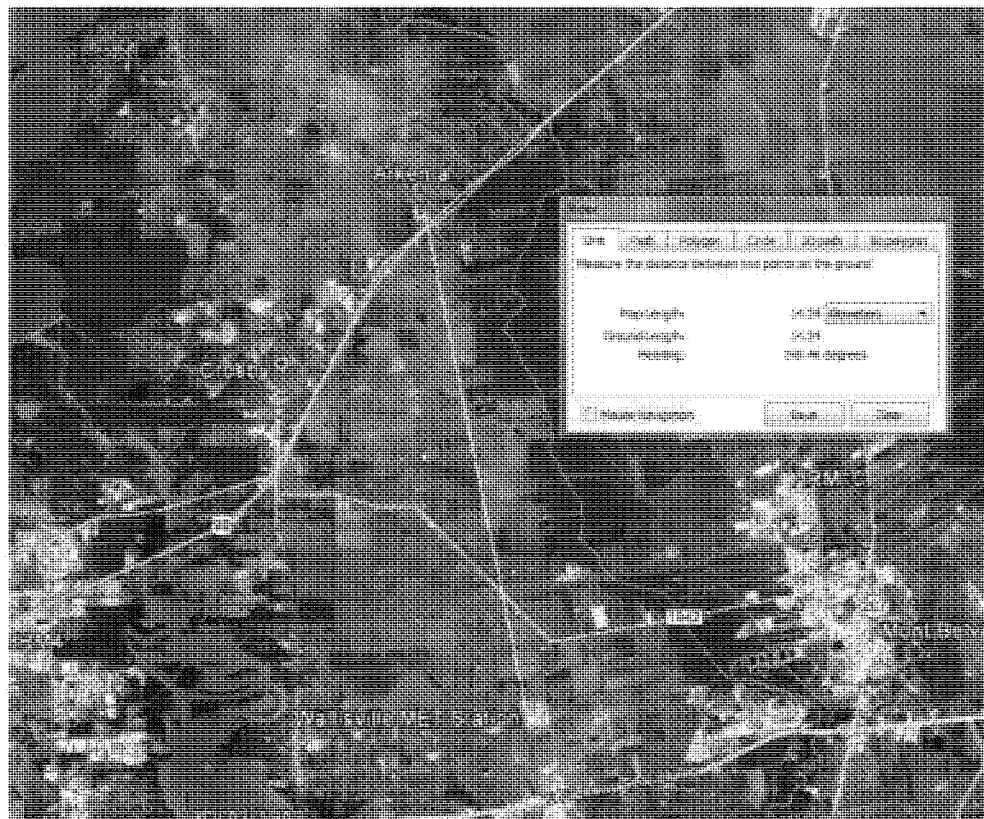
In order to identify meteorological data most representative of the area surrounding the Crosby Plant during the emissions events, Arkema reviewed meteorological data collected by the National Weather Service (NWS), from the TCEQ monitoring network (TAMIS), from the Houston Regional Monitoring (HRM) network, and from other sites in the Crosby Plant area. Review of the sites in the area revealed that the NWS and TCEQ sites remained operational over the period of record of interest (approximately August 28, 2017, through September 4, 2017) whereas most HRM sites were lowered and/or taken offline to withstand the hurricane force winds for portions of that period to withstand the hurricane force winds.

Based on the site proximity, similarity of land use and geographical setting, and general climatic features, the HRM Wallisville Road, Wallisville, TX station was identified as the most representative meteorological data set to represent the Crosby Plant.⁵² As shown in Figure 4-8, the HRM Wallisville Road Monitor is located approximately 14 km south of the Crosby Plant, is in similar terrain as the Crosby Plant, is located inland away from the Gulf, and is closer to the Crosby Plant than the George Bush Intercontinental Airport monitor (located 30 km west of Arkema). The Wallisville HRM site remained operational throughout the period but was lowered from its normal 10 m (32.8 ft) height from August 25, 2017, at 06:00 hours to August 31, 2017, 10:10 hours to a

⁵²http://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view_site&siteID=759&siteOrderBy=name&showActiveOnly=0&showActMonOnly=1&formSub=1&tab=pics

height of 4.27 m (14 ft). Even at this lower height the station was still operational and therefore, still useful. Other backyard and non-certified sites were not considered for this modeling effort.

Figure 4-8. Location of the HRM Wallisville Meteorological Data Station



4.6.1. Meteorological Data Processing - Surface Data

Hourly meteorological data (wind speed, wind direction, temperature, standard deviation of wind direction (sigma theta), and net radiation) for the period of record of interest was obtained from the HRM Wallisville Road Monitor and processed along with surface data from the George Bush International Airport (KIAH, WBAN No. 12960).⁵³ In the Stage 1 application of AERMET (Version 16216), the Wallisville data was treated as on-site data to facilitate its entry into the processor. Thus, use of the Wallisville data was always prioritized in the processing. Unprocessed hourly surface meteorological field data was also obtained from the U.S. National Climatic Data Center (NCDC) for the George Bush Intercontinental Airport, KIAH for August 28, 2017, through September 4, 2017, in the standard integrated surface hourly data (ISHD, or TD-3505) format.⁵⁴ The KIAH data was supplemented with TD-6405 (so-called "1-minute") wind data, processed using the latest version of the

⁵³ As of the writing of this modeling report, the data collected from the HRM Wallisville Road Monitor has not been validated by the TCEQ.

⁵⁴ <ftp://ftp.ncdc.noaa.gov/pub/data/noaa/>

AERMINUTE one minute data processing tool (Version 15272).⁵⁵ A threshold wind speed of 0.5 m/s was used in AERMET consistent with U.S. EPA guidance. The Wallisville raw data was recorded in Central Standard Time (CST). AERMET and AERMOD are designed to work in Local Standard Time (LST), and thus no time zone shift was performed for the Wallisville data. The KIAH airport data was recorded in UTC. Thus, AERMET's time zone shift parameter was set to subtract 6 hours from the KIAH data observation times in order to properly convert them to the CST that is used by AERMET and AERMOD. Because some of the emissions event data was recorded in Central Daylight Time, when defining the start and end times for each event, care was taken to ensure that the start and end times in AERMET and AERMOD were properly selected to match the actual start and end times of the events. The "Ice-Free Winds Group" AERMINUTE option was selected and applied in AERMINUTE due to the fact that a sonic anemometer was installed at KIAH on June 11, 2009.⁵⁶ Because the Wallisville tower was lowered from its normal 10 m height to 4.27 m during the passage of Hurricane Harvey from August 25 06:00 hours to August 31 10:10 hours, the actual measurement height for each hour in the period was included as part of the raw onsite data provided to AERMET. By reading in this data, AERMET is able to properly account for the fact that the anemometer height changed during the course of the storm.

Use of the lowered wind sensors from 10 m to 4.27 m is justified for the following reasons. First, anemometers can be at any height above ground as long as the sensor is located properly on the supporting structure and free of obstructions. Many wind instruments at airports are located at heights lower than the standard 10 m and are still used in dispersion modeling studies. As long as the height above-grade of the anemometer is known and provided to the model, the AERMOD model has formulations which can adjust the measured wind speed to the height of each source release using the given height of the sensors as the base height in the calculations.

Due to expected high wind speeds, the tower on which the anemometer and vane were mounted was lowered to a height of 4.27 m and remained at that height throughout the modeled period for Event 1 of August 29. For the hours at this lower height, the inputs to AERMET were adjusted to account for the height change while keeping the height at 10 m for all other hours (this can be viewed in the surface files provided to TCEQ, namely, "WALLISVILLE_ARKEMALU_HgtShift_NoADJU.SFC").

To further demonstrate that the 4.27 m height wind speeds were applicable within the range of nearby roughness heights, the height of the wind measurement was evaluated to determine if near-ground mechanical turbulence distorting the wind measurements might occur. EPA's *AERMOD Model Formulation and Evaluation*⁵⁷ document addresses this condition in Section 2 *Model Overview*. As the document states, AERMET and AERMOD use a required minimum wind measurement height above ground level that is equal to 7 times the surface roughness (z_0) in the area. The results of the AERSURFACE land use analysis of the Wallisville monitor location indicated that the highest surface roughness value for any direction around the monitor is 0.26 meters. Thus, using the AERMOD 7 times z_0 calculation gives a minimum acceptable anemometer height for this location at 1.82 m. The 4.27 m tower height in this case is well above this minimum value and thus was appropriate for use with AERMOD.

4.6.2. Meteorological Data Processing - Upper Air Data

Upper air measurements are also required in the modeling in addition to surface meteorological data. AERMET requires the use of data from an upper air sounding to estimate mixing heights and to assist in the calculation of the temperature and turbulence profiles. Upper air data from the nearest representative U.S. National Weather

⁵⁵ <ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin>

⁵⁶ http://www.nws.noaa.gov/ops2/Surface/documents/IFW_stat.pdf

⁵⁷ *AERMOD Model Formulation and Evaluation*, EPA-454/R-17-001, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 2017.

Service (NWS) radiosonde-equipped station was utilized in the preparation of the meteorological data sets. In this case the TCEQ upper air station choice for Harris County used in air permit modeling and also the closest representative upper air station was that at Lake Charles Airport (KLCH, WBAN No. 03937), which is about 185 km east northeast of the Crosby Plant. Data were obtained from the National Oceanic and Atmospheric Administration (NOAA) in FSL (Forecast Systems Laboratory) format for August 28, 2017, through September 4, 2017.⁵⁸ As with the KIAH airport weather data, the raw upper air data uses UTC as the time zone, and thus the appropriate 6-hour adjustment was applied using AERMET's time zone shift parameter.

4.6.3. Meteorological Data Processing - Land Use Analysis

A land use analysis characterizes the features that can affect meteorological parameters and the model derivation of turbulence. Three specific parameters are required by AERMET and are derived from the land use; surface roughness parameter, Bowen ratio, and albedo. In accordance with U.S. EPA guidance, these values are determined using the latest version of the AERSURFACE tool (version 13016).⁵⁹ AERSURFACE reads gridded land use, land cover data as provided by the USGS and associates the data with representative values of the three parameters listed above.⁶⁰ The land use analysis is based on the moisture conditions at the Crosby Plant at the time of the selected data set (wet). The AERSURFACE processor was run with 12, 30-degree sectors for determining the surface roughness parameters. Other specific AERSURFACE settings were used that represent the location of the Crosby Plant. These settings included location coordinates, seasonal variation (summer), aridity (non-arid), and the surface moisture determination (wet) which was just discussed.

4.6.4. Meteorological Data Processing

Following the collection of the Wallisville data, the KIAH surface data, and the KLCH upper air meteorological data, the AERMET processor was used as described above to process the Stage 1, 2, and 3 analyses. The results of this processing include a surface and profile files for August 28, 2017, through September 4, 2017. Both files are used in the AERMOD modeling. The AERMET surface, and profile files are described in Section 7 and provided with the electronic files.

Because each event is of finite duration over a specified period of time, all hours of meteorology that are part of the surface and data files generated by AERMET are not processed for each event. Rather only the hours of each event are processed in AERMOD with the sources for that event. To facilitate this selection the meteorology section of AERMOD (ME keyword) has a functional keyword, namely, STARTEND, that allows the selection of the day (s) and hour (s) where the modeling will start and end. This function was used to select the appropriate beginning and ending hours to process for each event in the modeling. As noted above, AERMET and AERMOD are designed to use LST, even during Daylight Savings Time. Thus, the one hour shift between Standard and Daylight time was accounted for when defining start/end times in AERMOD.

⁵⁸ <http://www.esrl.noaa.gov/raobs/>

⁵⁹ U.S. Environmental Protection Agency. 2013. "AERSURFACE User's Guide." EPA-454/B-08-001, Revised 01/16/2013. Available Online: http://www.epa.gov/scram001/7thconf/aermod/aersurface_userguide.pdf

⁶⁰ <http://www.mrlc.gov/viewerjs/>

5. MODELING RESULTS

The maximum modeled ground-level concentrations obtained using the approach described in Section 4 are presented in this section. The electronic files including model input files, preprocessor files, meteorological data files, and model output files and results are included in Section 7. The remainder of this Section 5 presents a tabular summary and comparison to applicable ambient air standards and TCEQ benchmarks as well as plots showing the locations of maximum impacts for each event as well as the area distribution and normalized concentration gradient of ambient impacts.

As the emissions events occurred during different discrete time periods, the modeled impacts are reported on a per-event basis.

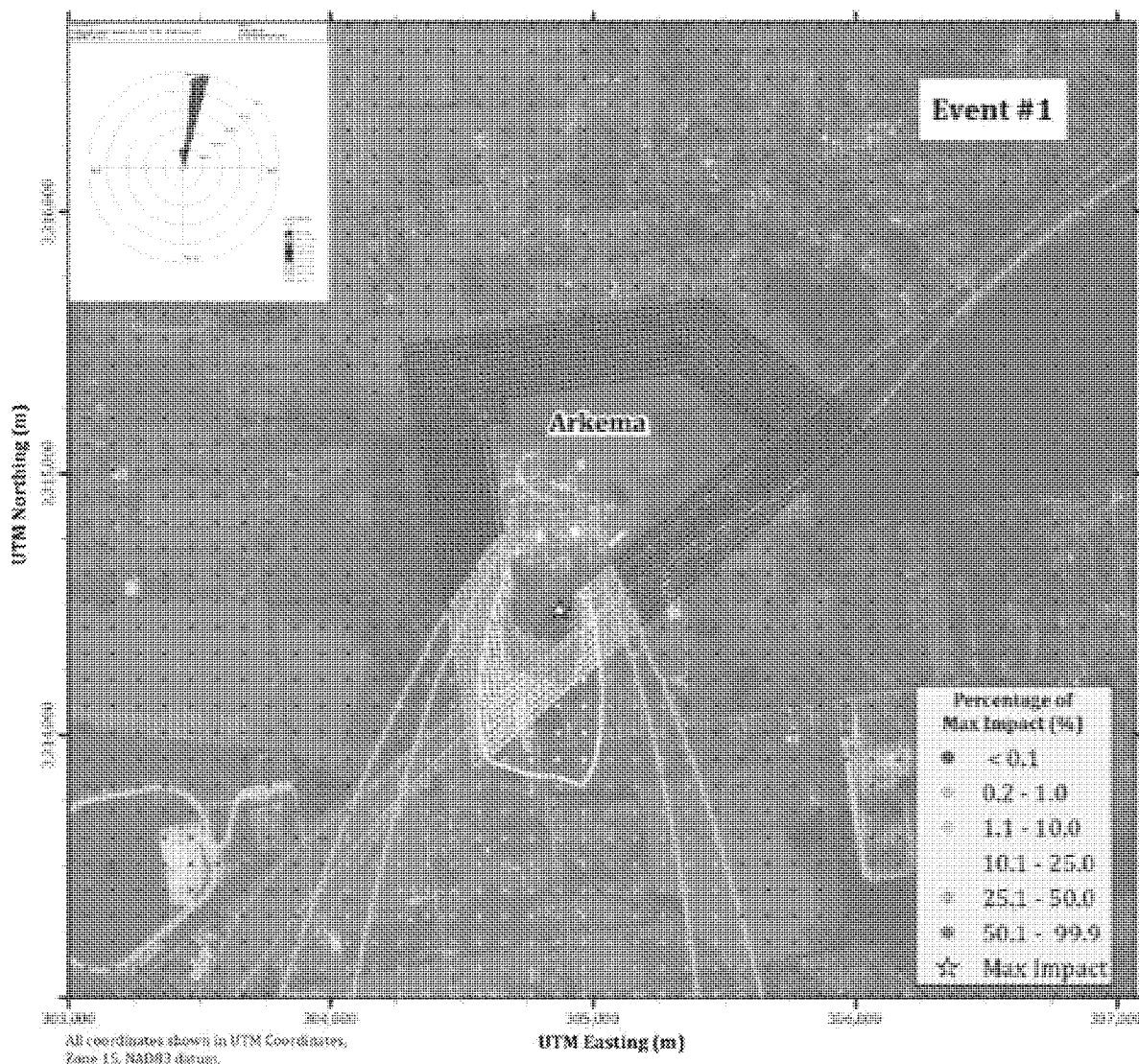
5.1. EVENT ONE (INCIDENT NUMBER 267578): WASTEWATER TANKS (14-T-2A/2B) OVERFLOW

The modeled 1-hour ambient concentration impacts from the wastewater tank overflow event are summarized in Table 5-1. The modeled emission rate represents the average hourly rate for the duration of the event. As can be seen all maximum 1-hour concentrations are less than their applicable AMCV or ESL (the lower of the two are used in the model-to-benchmark comparisons). Figure 5-1 shows the maximum location of the unit emissions (1.0 g/s) Event 1 release, the concentration isopleths as a function of percent of the maximum concentration, and the accompanying wind rose indicating the direction from which the wind was blowing during the event. Because this figure is for unit emissions, the magnitude of the maximum is not presented but was rather used along with event emissions to provide the maximum ambient impacts in Table 5-1.

Table 5-1. Event One Maximum 1-Hour Modeled Concentrations: Health Effects Analysis

Constituent	CAS No.	AMCV?	AMCV or ESL ($\mu\text{g}/\text{m}^3$)	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Modeled Impacts < AMCV or ESL?
T-Amyl Alcohol	75-85-4	N	320	24.1	Yes
T-Butyl Alcohol	75-65-0	N	620	5.0	Yes
Di-T-Butyl Peroxide	110-05-4	N	100	21.0	Yes
Di-T-Amyl Peroxide	10508-09-5	N	100	12.7	Yes
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	78-63-7	N	100	1.2	Yes
Ethyl Benzene	100-41-4	Y	86,000	20.2	Yes
Naphthalene (Crude Or Refined)	91-20-3	Y	500	17.6	Yes
1, 2, 4 - Trimethylbenzene	95-63-6	Y	15,000	93.0	Yes
Hydrotreated Heavy Naphtha	64742-48-9	N	3,000	17.6	Yes
Odorless Mineral Spirits (OMS)	68551-17-7	N	3,500	130.4	Yes
Naphtha, light aromatic	64742-95-6	N	4,400	289.6	Yes
Xylene, mixed isomers	1330-20-7	N	2,200	21.1	Yes

Figure 5-1. Event One 1-Hour Unit Emissions Concentration Plot



5.2. EVENT TWO (INCIDENT NUMBER 267679): ORGANIC PEROXIDES STORAGE TRAILER NO. 1 COMBUSTION

The modeled 1-hour ambient concentration impacts from one storage trailer (Trailer No. 1) decomposition and combustion event are summarized in Table 5-2, Table 5-3, and Table 5-4 respectively, for the NAAQS, for State Property Line Analysis, and for either the AMCV or ESL. Event 2 was modeled as two sources. The first source represented the 30 min of product decomposition (Vapor). The modeled emission rate for the decomposition source represents the average emission rate for the duration of the decomposition event (0.5 hour). The second source represents the combustion of the remaining product and trailer(s) (Fire). The modeled emission rate represents the average emission rate for the duration of the combustion event (1.5 hours). All constituents were

not emitted by both sources and the selection of the appropriate maximum unit emissions-based concentration from the modeling (either decomposition or fire) was made and was prorated to the individual constituent release emission rates. As can be seen the concentrations for all identified NAAQS-related values are less than the respective values and averaging periods as shown in Table 5-2 (for averaging periods longer than the duration of the event, hours of no-event were assumed to have zero contribution in the calculation of the appropriate period). Table 5-2 shows that SO₂ was less than the State Property Line Analysis 1-hour threshold. Table 5-3 shows that the maximum 1-hour concentrations for the remainder of the volatile constituents, except for Odorless Mineral Spirits (OMS) and Acetophenone, are less than their applicable AMCV or ESL (where an existing AMCV value takes priority over the ESL). Figures 5-2 and 5-3, respectively show the maximum location of the unit emissions (1.0 g/s) Event 2 decomposition (vapor) release and the Event 2 fire. Each figure also shows the concentration isopleths as a function of percent of the maximum concentration.

Table 5-2. Event Two Modeled Impacts: NAAQS Analysis

Pollutant	Averaging Period	NAAQS (µg/m ³)	Maximum Modeled Impact (µg/m ³)	Modeled Impacts < NAAQS?
CO	1-hour	40,000	29.4	Yes
	8-hour	10,000	5.5	Yes
NO ₂	1-hour	188	1.8	Yes
SO ₂	1-hour	196	0.22	Yes
	3-hour	1,300	0.11	Yes
	24-hour	365	0.01	Yes
PM ₁₀	24-hour	50	1.2	Yes
PM _{2.5}	24-hour	35	1.2	Yes
Pb	3-month	0.15	0.000024	Yes

Table 5-3. Event Two Modeled Impacts: State Property Line Analysis

Pollutant	Averaging Period	State Property Line Standard (µg/m ³)	Maximum Modeled Impact (µg/m ³)	Modeled Impacts < State Property Line Standard?
SO ₂	1-hour	715	0.22	Yes

Table 5-4. Event Two Maximum 1-Hour Modeled Concentrations: Health Effects Analysis

Constituent	CAS No.	AMCV?	AMCV or ESL (µg/m ³)	Maximum Modeled Impact (µg/m ³)	Modeled Impacts < AMCV or ESL?
Nonane	111-84-2	Y	16,000	15,759	Yes
Nonene	124-11-8	N	5,800	5,206	Yes
OMS	68551-17-7	N	3,500	16,734	No
Acetone	67-64-1	Y	26,000	7.5	Yes
Acetophenone	98-86-2	N	490	19,684	No
2-Ethyl hexanol	104-76-7	N	540	16.6	Yes
2-Ethyl hexanal	123-05-7	N	1,400	5.4	Yes
Hydrofluoric Acid	7664-39-3	N	3	0.1	Yes

An accompanying wind rose indicating the direction from which the wind was blowing during the event or event-subset is also provided in each figure. Because these figures are for unit emissions, the magnitude of the maximum is not presented but was rather used as appropriate to account for impacts due to decomposition r fire along with event emissions to provide the maximum ambient impacts in Tables 5-2 through 5-4. The plume shapes, concentration gradients, and directions would be the same for each constituent modeled.

Figure 5-2. Event Two 1-Hour Unit Emissions Concentration Plot for the Decomposition Phase

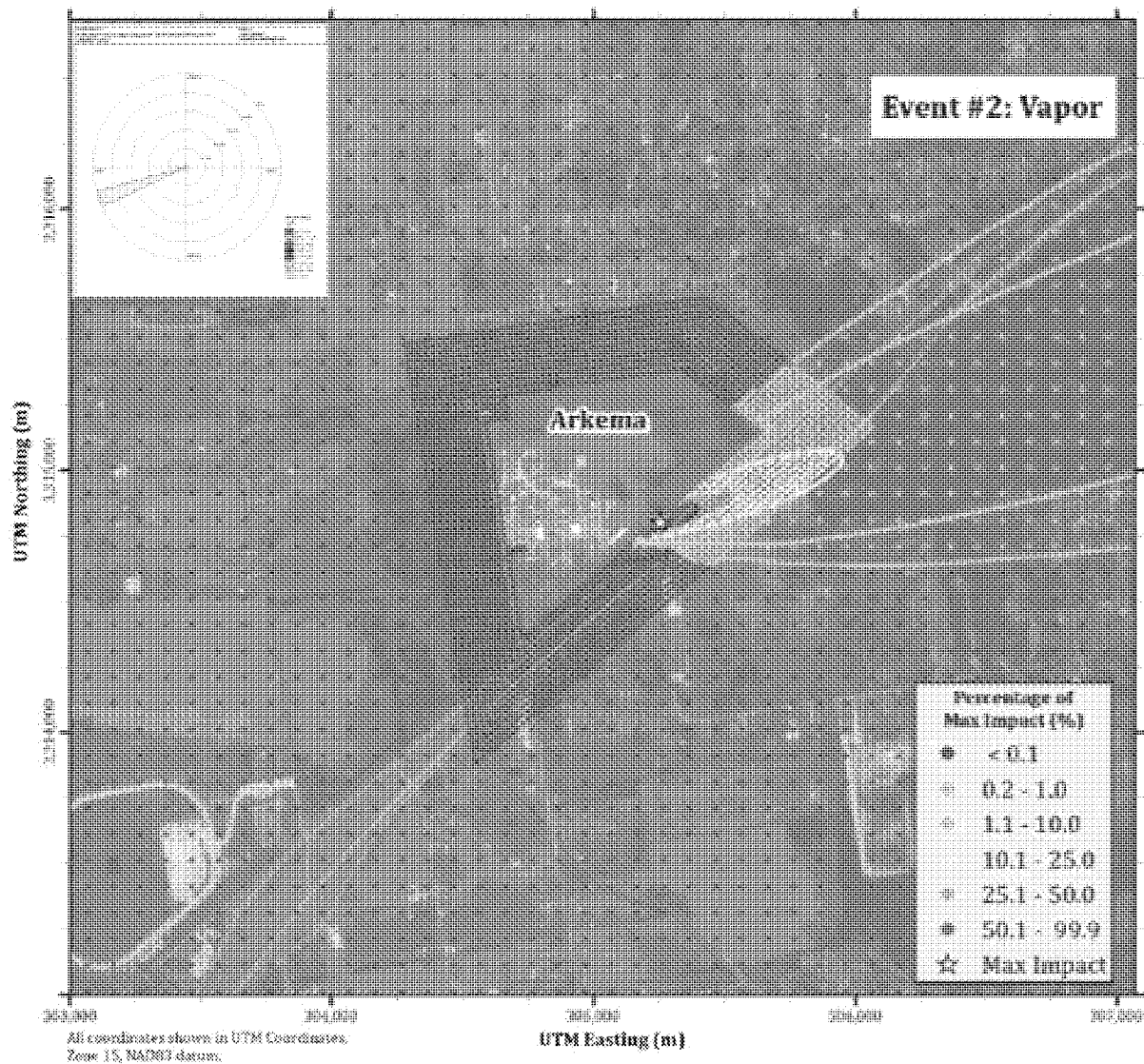
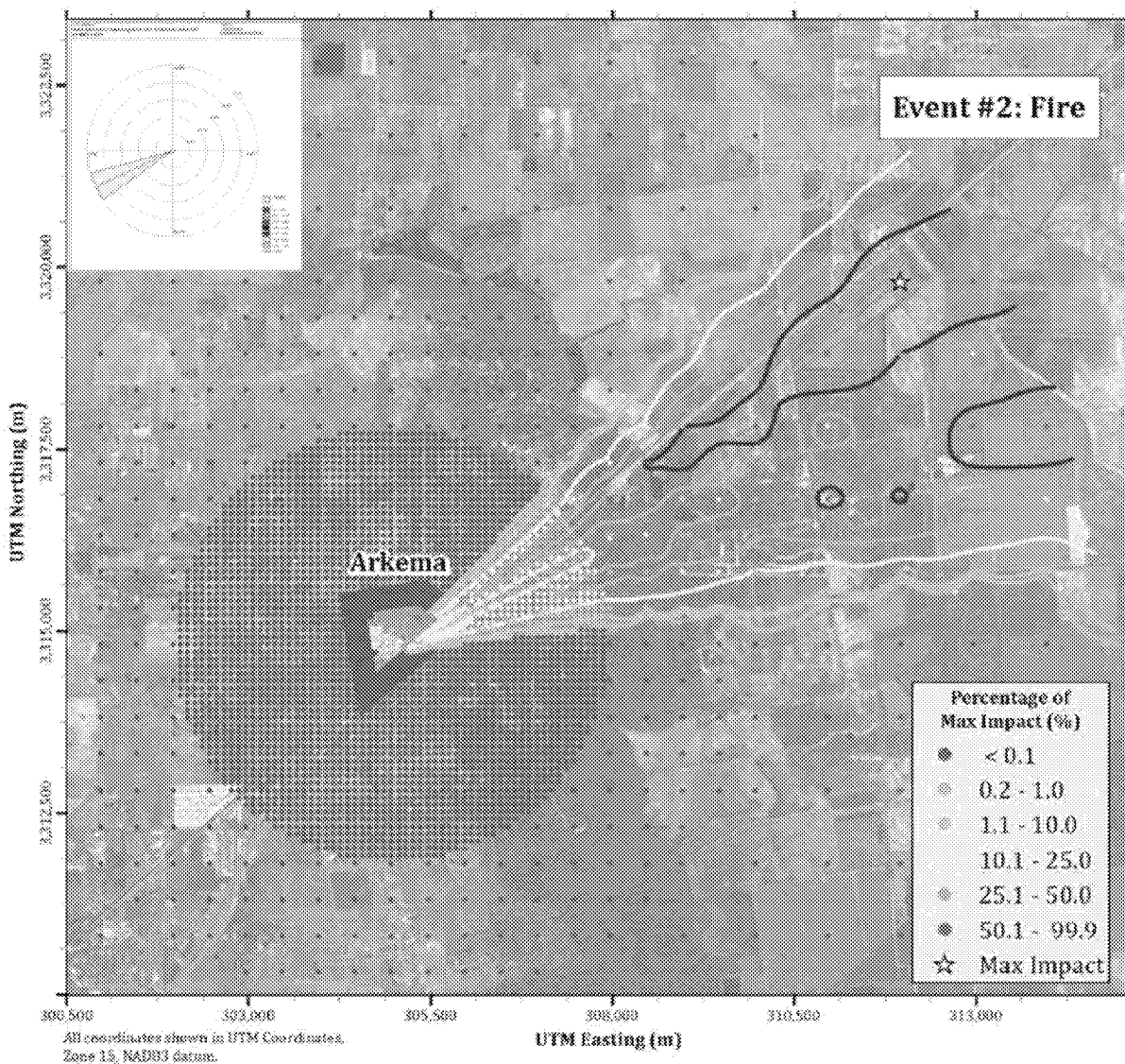


Figure 5-3. Event Two 1-Hour Unit Emissions Concentration Plot for the Burn Phase



5.3. EVENT THREE (INCIDENT NUMBER 266756): ORGANIC PEROXIDES STORAGE TRAILERS NOS. 2-3 COMBUSTION

The modeled 1-hour ambient concentration impacts from the second storage trailer (Trailers Nos. 2 and 3) decomposition and combustion event are summarized in Table 5-5, Table 5-6, and Table 5-7 respectively for the NAAQS, for State Property Line Analysis, and for either the AMCV or ESL. Event 3 was modeled as two sources. The first source represented the 30 min of product decomposition (Vapor). The modeled emission rate for the decomposition source represents the average emission rate for the duration of the decomposition event (.5 hour). The second source represents the combustion of the remaining product and trailer(s) (Fire). The modeled emission rate represents the average emission rate for the duration of the combustion event (1.5 hours). All

constituents were not emitted by both sources and the selection of the appropriate maximum unit emissions-based concentration from the modeling (either decomposition or fire) was made and was prorated to the individual constituent release emission rates. As can be seen the concentrations for all identified NAAQS-related values are less than the respective values and averaging periods as shown in Table 5-5 (for averaging periods longer than the duration of the event, hours of no-event were assumed to have zero contribution in the calculation of the appropriate period). Table 5-6 shows that SO₂ was less than the State Property Line Analysis 1-hour threshold. Table 5-7 shows that for the remainder of the constituents that the maximum 1-hour concentrations are less than their applicable AMCV or ESL (where an existing AMCV value takes priority over the ESL). Figures 5-4 and 5-5, respectively show the maximum location of the unit emissions (1.0 g/s) Event 3 decomposition (vapor) release and the Event 3 fire. Each figure also shows the concentration isopleths as a function of percent of the maximum concentration, and the accompanying wind rose indicating the direction from which the wind was blowing during the event or event-subset. Because these figures are for unit emissions, the magnitude of the maximum is not presented but was rather used as appropriate to account for impacts due to decomposition or fire along with event emissions to provide the maximum ambient impacts in Tables 5-5 through 5-7.

Table 5-5. Event Three Modeled Impacts: NAAQS Analysis

Pollutant	Averaging Period	NAAQS (µg/m ³)	Maximum Modeled Impact (µg/m ³)	Modeled Impacts < NAAQS?
CO	1-hour	40,000	3.65	Yes
	8-hour	10,000	0.68	Yes
NO ₂	1-hour	188	0.19	Yes
SO ₂	1-hour	196	0.04	Yes
	3-hour	1,300	0.02	Yes
	24-hour	365	0.003	Yes
PM ₁₀	24-hour	50	0.16	Yes
PM _{2.5}	24-hour	35	0.16	Yes
Pb	3-month	0.15	0.0000045	Yes

Table 5-6. Event Three Modeled Impacts: State Property Line Analysis

Pollutant	Averaging Period	State Property Line Standard (µg/m ³)	Maximum Modeled Impact (µg/m ³)	Modeled Impacts < State Property Line Standard?
SO ₂	1-hour	715	0.04	Yes

Table 5-7. Event Three Maximum 1-Hour Modeled Concentrations: Health Effects Analysis

Constituent	CAS No.	AMCV?	ESL or AMCV ($\mu\text{g}/\text{m}^3$)	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Modeled Impacts < AMCV or ESL?
Nonane	111-84-2	Y	16,000	451	Yes
Nonene	124-11-8	N	5,800	148	Yes
OMS	68551-17-7	N	3,500	240	Yes
Acetone	67-64-1	Y	26,000	0.78	Yes
Acetophenone	98-86-2	N	490	282	Yes
2-Ethyl hexanol	104-76-7	N	540	0.16	Yes
2-Ethyl hexanal	123-05-7	N	1,400	0.16	Yes
Hydrofluoric Acid	7664-39-3	N	3	0.01	Yes

Figure 5-4. Event Three 1-Hour Unit Emissions Concentration Plot for the Decomposition Phase

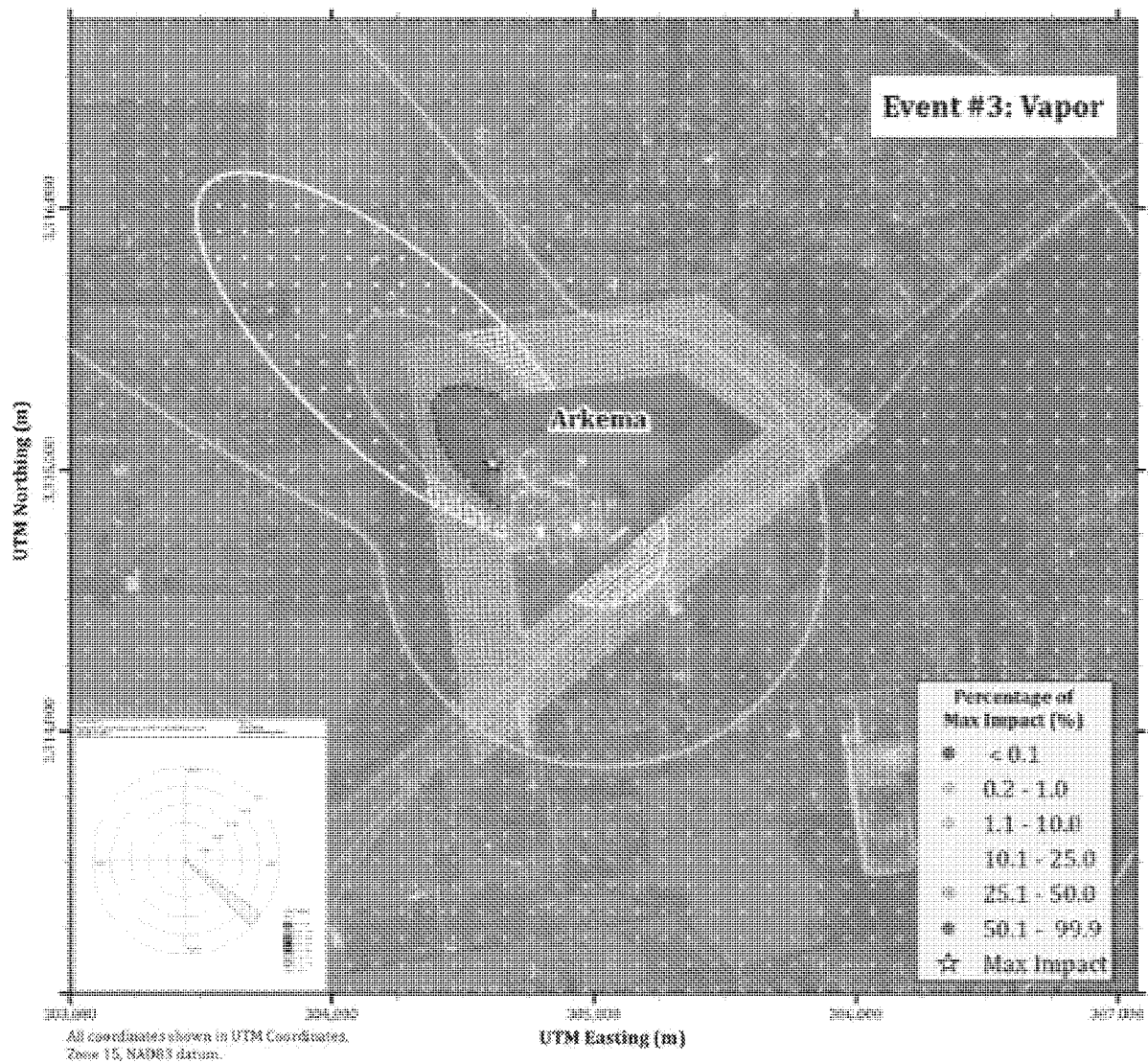
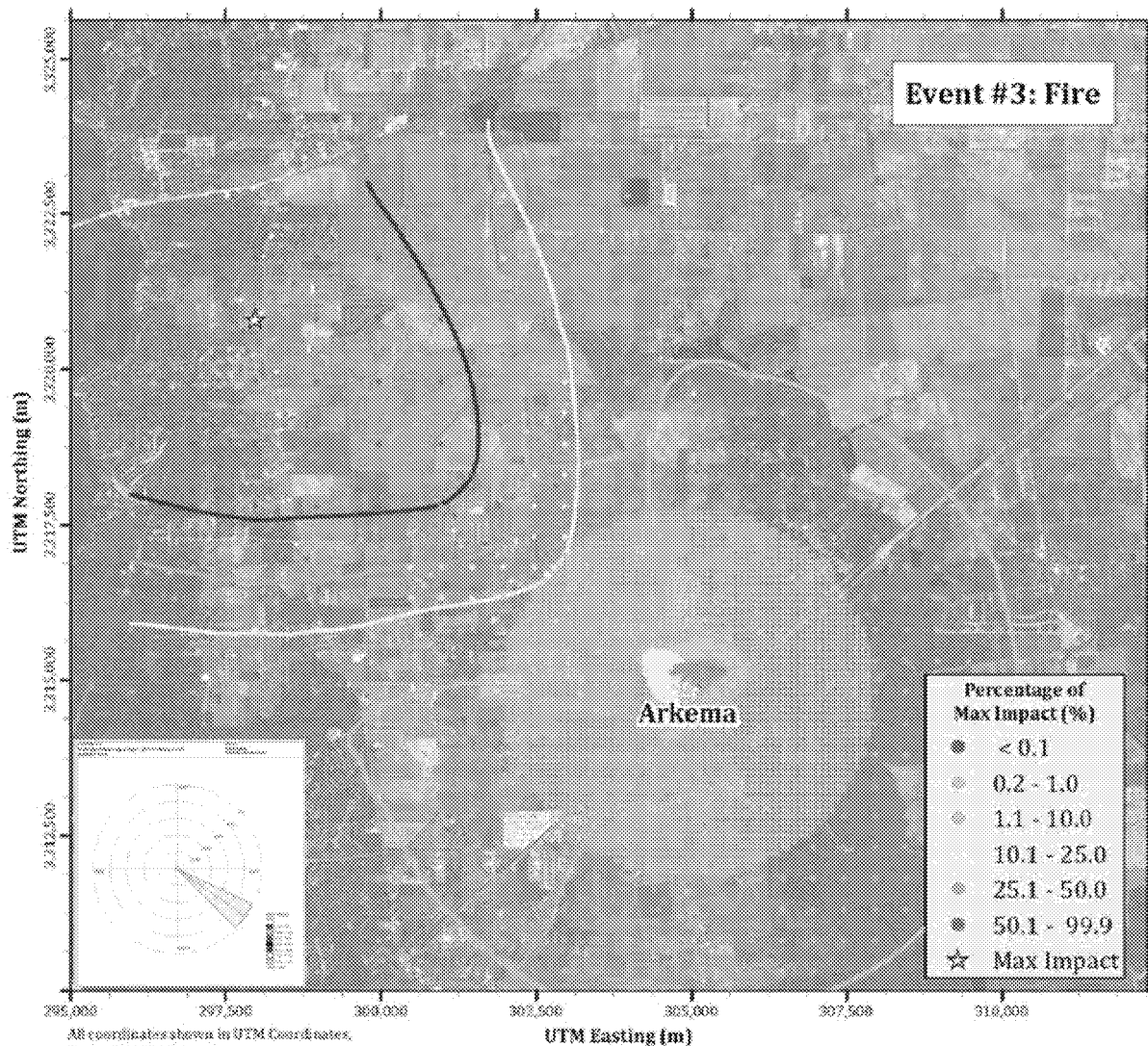


Figure 5-5. Event Three 1-Hour Unit Emissions Concentration Plot for the Burn Phase



5.4. EVENT FOUR (INCIDENT NUMBER 266771): ORGANIC PEROXIDES STORAGE TRAILERS NOS. 4-9 PRODUCT DECOMPOSITION

The modeled 1-hour ambient concentration impacts from the decomposition (Vapor) of two trailers in the Trailer Nos. 4-9 storage area (Trailers Nos. 5 and 8) are summarized in Table 5-8 for either the AMCV or ESL. The modeled emission rate represents the average hourly rate for the duration of the event. As can be seen the concentrations for all identified constituents that the maximum 1-hour concentrations are less than their applicable AMCV or ESL (the lower of the two are used in the model-to-benchmark comparisons). Figure 5-6 shows the maximum location of the unit emissions (1.0 g/s) Event 4 decomposition (vapor) release as well as the concentration isopleths as a function of percent of the maximum concentration, and the accompanying wind rose indicating the direction from which the wind was blowing during the event. Because this figure is for unit

emissions, the magnitude of the maximum is not presented but was rather used along with event emissions to provide the maximum ambient impacts in Table 5-8.

Table 5-8. Event Four Maximum 1-Hour Modeled Concentrations: Health Effects Analysis

Constituent	CAS No.	AMCV?	AMCV or ESL ($\mu\text{g}/\text{m}^3$)	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Modeled Impacts < AMCV or ESL?
Isobutane	75-28-5	Yes	23,000	89.4	Yes
Isobutene	115-11-7	Yes	180,000	28.8	Yes
OMS	68551-17-7	Yes	3,500	197.2	Yes
Acetone	67-64-1	Yes	26,000	119.1	Yes

5.5. EVENT FIVE (INCIDENT NUMBER 266778): ORGANIC PEROXIDES STORAGE TRAILERS NOS. 4-9 COMBUSTION

The modeled 1-hour ambient concentration impacts from the third storage trailer (Trailers Nos. 4-9) combustion event are summarized in Table 5-9, Table 5-10, and Table 5-11, respectively for the NAAQS, for State Property Line Analysis, and for either the AMCV or ESL. The modeled emission rate represents the average hourly rate for the duration of the event. As can be seen the concentrations for all identified NAAQS-related values are less than the respective values and averaging periods as shown in Table 5-9 (for averaging periods longer than the duration of the event, hours of no-event were assumed to have zero contribution in the calculation of the appropriate period). Table 5-10 shows that SO_2 was less than the State Property Line Analysis 1-hour threshold. Table 5-11 shows that for the remainder of the constituents that the maximum 1-hour concentrations are less than their applicable AMCV or ESL (the lower of the two are used in the model-to-benchmark comparisons). Figure 5-7 shows the maximum location of the unit emissions (1.0 g/s) Event 5 fire. The figure also shows the concentration isopleths as a function of percent of the maximum concentration, and the accompanying wind rose indicating the direction from which the wind was blowing during the event or event-subset. Because this figure is for unit emissions, the magnitude of the maximum is not presented but was rather used along with event emissions to provide the maximum ambient impacts in Tables 5-9 through 5-11.

Figure 5-6. Event Four 1-Hour Unit Emissions Concentration Plot for the Decomposition Phase

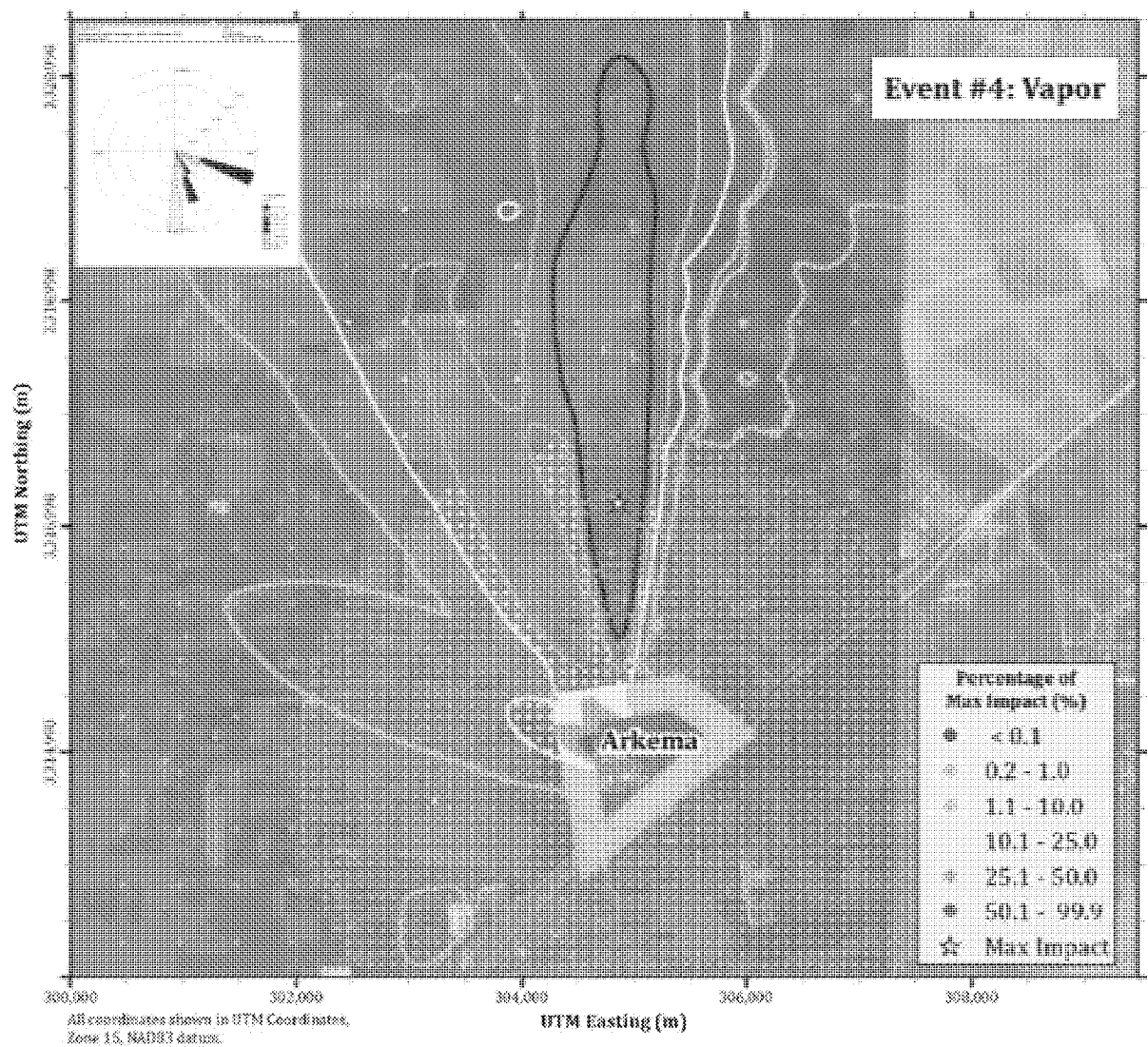


Table 5-9. Event Five Modeled Impacts: NAAQS Analysis

Pollutant	Averaging Period	NAAQS ($\mu\text{g}/\text{m}^3$)	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Modeled Impacts < NAAQS?
CO	1-hour	40,000	9.22	Yes
	8-hour	10,000	2.31	Yes
NO ₂	1-hour	188	0.48	Yes
SO ₂	1-hour	196	0.09	Yes
	3-hour	1,300	0.06	Yes
	24-hour	365	0.01	Yes
PM ₁₀	24-hour	50	0.54	Yes
PM _{2.5}	24-hour	35	0.54	Yes
Pb	3-month	0.15	0.000015	Yes

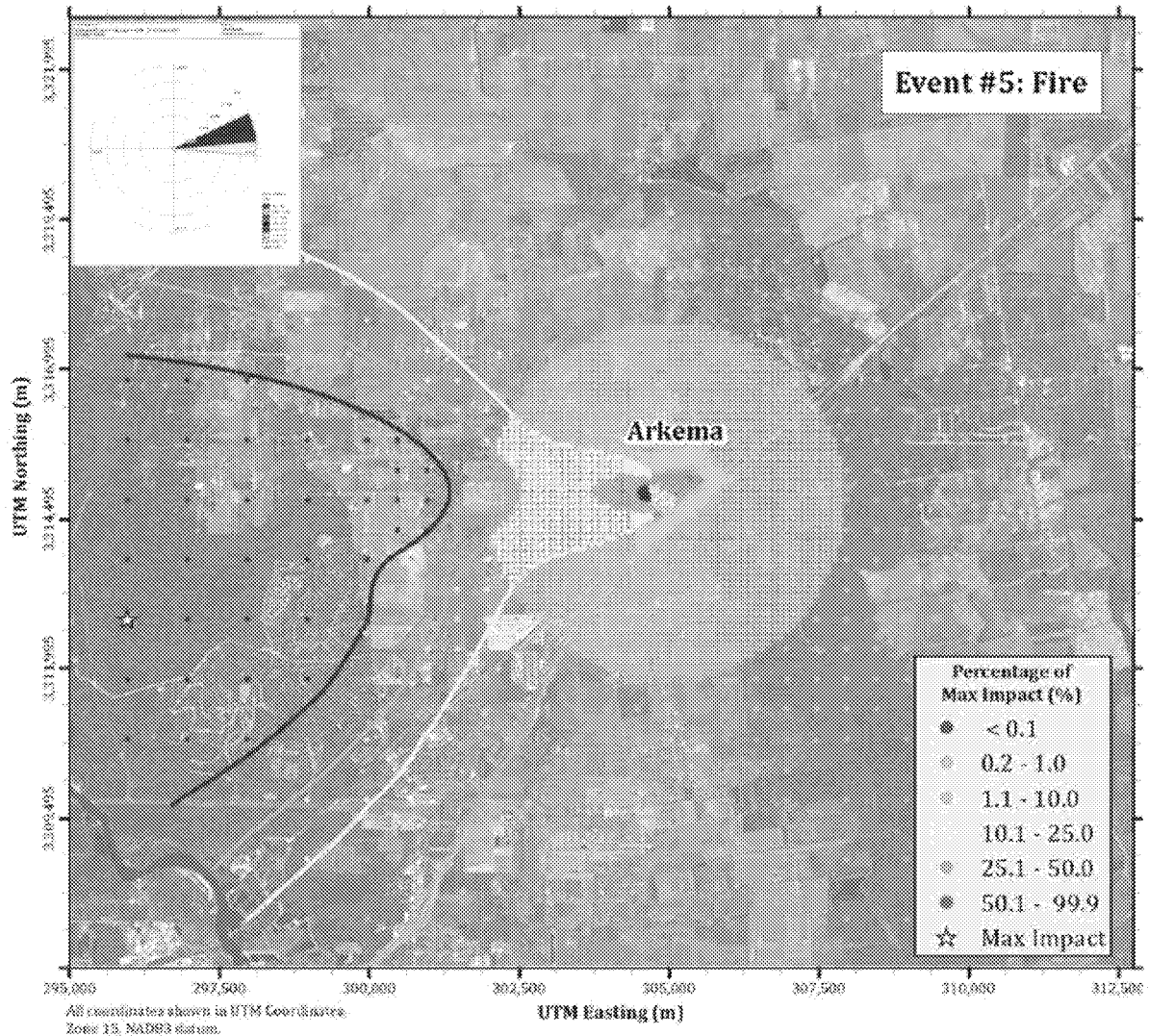
Table 5-10. Event Five Modeled Impacts: State Property Line Analysis

Pollutant	Averaging Period	State Property Line Standard ($\mu\text{g}/\text{m}^3$)	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Modeled Impacts < State Property Line Standard?
SO ₂	1-hour	715	0.09	Yes

Table 5-11. Event Five Maximum 1-Hour Modeled Concentrations: Health Effects Analysis

Constituent	CAS No.	AMCV?	AMCV or ESL ($\mu\text{g}/\text{m}^3$)	Maximum Modeled Impact ($\mu\text{g}/\text{m}^3$)	Modeled Impacts < AMCV or ESL?
Nonane	111-84-2	Y	16,000	3.43	Yes
Nonene	124-11-8	N	5,800	1.13	Yes
Isobutane	75-28-5	Y	78,000	0.76	Yes
Isobutene	115-11-7	Y	620,000	0.24	Yes
n-propanol	71-23-8	N	2,460	0.10	Yes
n-propanal	123-38-6	Y	1,800	0.03	Yes
sec-butanol	78-92-2	N	3,000	0.33	Yes
sec-butanone	78-93-3	Y	59,000	0.11	Yes
OMS	68551-17-7	N	3,500	3.94	Yes
Acetone	67-64-1	Y	26,000	2.37	Yes
Acetophenone	98-86-2	N	490	1.46	Yes
2-Ethyl hexanol	104-76-7	N	540	3.12	Yes
2-Ethyl hexanal	123-05-7	N	1,400	1.02	Yes
Hydrofluoric Acid	7664-39-3	N	3	0.03	Yes

Figure 5-7. Event Five 1-Hour Unit Emissions Concentration Plot for the Burn Phase



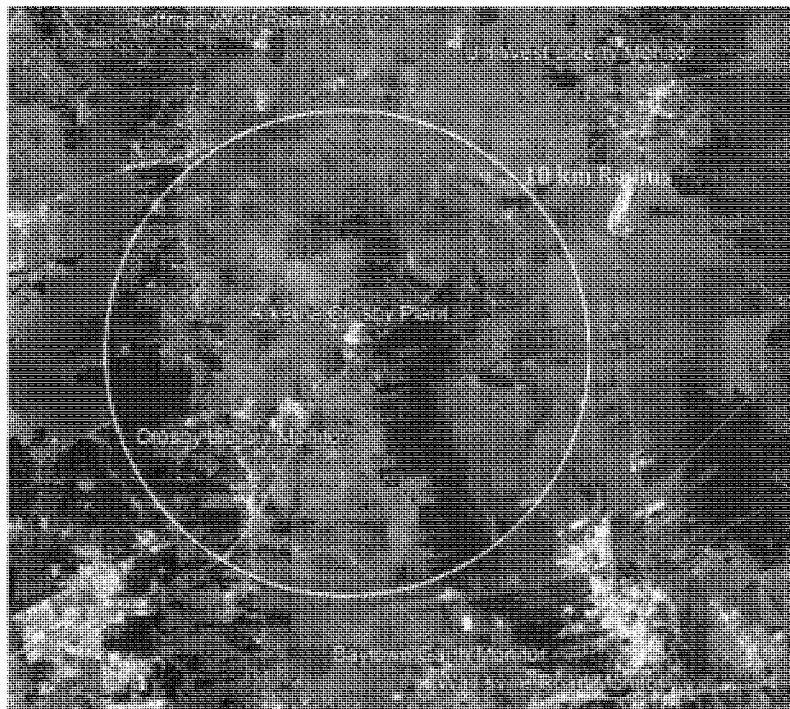
6. AMBIENT BACKGROUND MONITORING DATA

There are five ambient background monitoring stations located within 15 km of the Crosby Plant.⁶¹ Table 6-1 lists the monitors, their distance from the Crosby Plant, and the pollutants that each monitor measures. Figure 6-1. Ambient Background Monitors near the Crosby Plant shows the location of each monitor in proximity to the Crosby Plant.

Table 6-1. Ambient Background Monitors near the Crosby Plant

Monitor Name	AQS	CAMS	Distance from Crosby Plant (km)	Location Relative to Crosby Plant	Pollutants Measured
Crosby Library	48-201-0553	553	5.44	Southwest	Ozone
Huffman Wolf Road	48-201-0563	563	12.63	North-Northwest	Ozone
UH West Liberty	48-201-0699	699	12.84	North-Northeast	Ozone, NO ₂ , CO, PM _{2.5}
Baytown Garth	48-201-1017	1017	14.51	South-Southeast	Ozone, SO ₂
Wallisville Road	48-201-0617	617	14.58	South-Southeast	Ozone, NO ₂ , Speciated VOC

Figure 6-1. Ambient Background Monitors near the Crosby Plant



⁶¹ As obtained from https://www.tceq.texas.gov/cgi-bin/compliance/monops/select_year.pl?region=12, and the Houston Regional Monitoring (HRM) Network.

Arkema downloaded and reviewed the CO, SO₂, NO₂, PM_{2.5}, and speciated VOCs background monitored concentration data for the following time periods:

- The one (1) month period preceding the emissions events;
 - Date Range: July 29, 2017, through August 28, 2017
- The six (6) day period encompassing all five (5) emissions events;
 - Date Range: August 29, 2017, through September 3, 2017
- The two (2) hour period of each combustion event (i.e. Events 2, 3, and 5); and
 - Event 2: August 31, 2017; 02:00 hours through 04:00 hours
 - Event 3: September 1, 2017; 17:00 hours through 19:00 hours
 - Event 5: September 3, 2017; 15:40 hours through 17:40 hours
- The one (1) month period following the emissions events.
 - Date Range: September 4, 2017, through October 3, 2017

The tables in this section include the average and maximum background monitored concentration data (as available) before, during, and after the Crosby Plant emissions events.⁶² As shown in Table 6-2 through Table 6-9, the monitored concentrations are well below the applicable NAAQS standards, AMCVs, or ESLs, which is consistent with the modeling results included in Section 5 of this report.

Table 6-2: Average Monitored CO Concentrations Before, During, and Following the Crosby Plant Emissions Events

Monitor (CAMS)	Average Monitored Concentration Prior to Emissions Events ¹ (ppm)	Average Monitored Concentration During Crosby Plant Emissions Events ¹ (ppm)	Average Monitored Concentration Following Crosby Plant Emissions Events ¹ (ppm)	NAAQS (ppm)	
				1-hour	8-hour
699	0.1	0.22	0.18	35	9

¹ The time period prior to the emissions events is defined as the one (1) month period preceding the emissions events (July 29, 2017, through August 28, 2017). The time period during the emissions events is defined as the six (6) day period encompassing all five (5) emissions events (August 29, 2017, through September 3, 2017). The time period following the emissions events is defined as the one (1) month period following the emissions events (September 3, 2017, through October 3, 2017).

⁶² PM_{2.5} and speciated VOC data was obtained from the HRM network. Based on the availability of monitoring data, this analysis is limited to the review of background concentrations during the Crosby Plant emissions events.

Table 6-3. Average Monitored SO₂ Concentrations Before, During, and Following the Crosby Plant Emissions Events

Monitor (CAMS)	Average Monitored Concentration Prior to Emissions Events ¹ (ppb)	Average Monitored Concentration During Crosby Plant Emissions Events ¹ (ppb)	Average Monitored Concentration Following Crosby Plant Emissions Events ¹ (ppb)	NAAQS (ppb)		
				1-hour	3-hour	24-hour
1017	0.10	0.26	0.12	75	500	140

¹ The time period prior to the emissions events is defined as the one (1) month period preceding the emissions events (July 29, 2017, through August 28, 2017). The time period during the emissions events is defined as the six (6) day period encompassing all five (5) emissions events (August 29, 2017, through September 3, 2017). The time period following the emissions events is defined as the one (1) month period following the emissions events (September 3, 2017, through October 3, 2017).

Table 6-4. Average Monitored NO₂ Concentrations Before, During, and Following the Crosby Plant Emissions Events

Monitor (CAMS)	Average Monitored Concentration Prior to Emissions Events ¹ (ppb)	Average Monitored Concentration During Crosby Plant Emissions Events ¹ (ppb)	Average Monitored Concentration Following Crosby Plant Emissions Events ¹ (ppb)	NAAQS (ppb)
				1-hour
699	2.0	1.5	2.0	100
617	5.3	5.9	6.1	

¹ The time period prior to the emissions events is defined as the one (1) month period preceding the emissions events (July 29, 2017, through August 28, 2017). The time period during the emissions events is defined as the six (6) day period encompassing all five (5) emissions events (August 29, 2017, through September 3, 2017). The time period following the emissions events is defined as the one (1) month period following the emissions events (September 3, 2017, through October 3, 2017).

Table 6-5. Maximum Monitored CO Concentrations Before, During, and Following the Crosby Plant Emissions Events

Monitor (CAMS)	Maximum Monitored Concentration Prior to Emissions Events ¹ (ppm)	Maximum Monitored Concentration During Crosby Plant Emissions Events ¹ (ppm)			Maximum Monitored Concentration Following Crosby Plant Emissions Events ¹ (ppm)	NAAQS (ppm)	
		Event 2	Event 3	Event 5 ²		1-hour	8-hour
699	0.4	0.2	0.2	--	0.4	35	9

¹ The time period prior to the emissions events is defined as the one (1) month period preceding the emissions events (July 29, 2017, through August 28, 2017). Emissions Event 2 is defined as August 31, 2017, 02:00 hours through 04:00 hours. Emissions Event 3 is defined as September 1, 2017, 17:00 hours through 19:00 hours. Emissions Event 5 is defined as September 3, 2017, 15:40 hours through 17:40 hours. The time period following the emissions events is defined as the one (1) month period following the emissions events (September 3, 2017, through October 3, 2017).

² The data during Emissions Event 5 is listed as LST, which means the data is lost (either never collected or lost in communication).

Table 6-6. Maximum Monitored SO₂ Concentrations Before, During, and Following the Crosby Plant Emissions Events

Monitor (CAMS)	Maximum Monitored Concentration Prior to Emissions Events (ppb)	Maximum Monitored Concentration During Crosby Plant Emissions Events (ppb)			Maximum Monitored Concentration Following Crosby Plant Emissions Events (ppb)	NAAQS (ppb)		
		Event 2	Event 3	Event 5		1-hour	3-hour	24-hour
1017	0.4	--	0.3	0.2	2.3	75	500	140

¹ The time period prior to the emissions events is defined as the one (1) month period preceding the emissions events (July 29, 2017, through August 28, 2017). Emissions Event 2 is defined as August 31, 2017, 02:00 hours through 04:00 hours. Emissions Event 3 is defined as September 1, 2017, 17:00 hours through 19:00 hours. Emissions Event 5 is defined as September 3, 2017, 15:40 hours through 17:40 hours. The time period following the emissions events is defined as the one (1) month period following the emissions events (September 3, 2017, through October 3, 2017).

² The data during Emissions Event 2 is listed as QAS, which means TCEQ was performing a quality control audit during the time period.

Table 6-7. Maximum Monitored NO₂ Concentrations Before, During, and Following the Crosby Plant Emissions Events

Monitor (CAMS)	Maximum Monitored Concentration Prior to Emissions Events (ppb)	Maximum Monitored Concentration During Crosby Plant Emissions Events (ppb)			Maximum Monitored Concentration Following Crosby Plant Emissions Events (ppb)	NAAQS (ppb)
		Event 2	Event 3	Event 5		1-hour
699	7.0	1.4	1.3	0.8	9.5	100
617	21.5	9	6.1	4.7	27.8	

¹ The time period prior to the emissions events is defined as the one (1) month period preceding the emissions events (July 29, 2017, through August 28, 2017). Emissions Event 2 is defined as August 31, 2017, 02:00 hours through 04:00 hours. Emissions Event 3 is defined as September 1, 2017, 17:00 hours through 19:00 hours. Emissions Event 5 is defined as September 3, 2017, 15:40 hours through 17:40 hours. The time period following the emissions events is defined as the one (1) month period following the emissions events (September 3, 2017, through October 3, 2017).

Table 6-8. Monitored PM_{2.5} Concentrations during the Crosby Plan Emissions Events

Monitor	Maximum Monitored Concentration During Crosby Plant Emissions Events ¹ (µg/m ³)			Average Monitored Concentration During Crosby Plant Emissions Events ¹ (µg/m ³)	NAAQS (µg/m ³)
	Event 2 ²	Event 3	1-hour		24-hour
Wallisville Road (HRM Network)	--	17	17	14	35

¹ Emissions Event 2 is defined as August 31, 2017, 02:00 hours through 04:00 hours. Emissions Event 3 is defined as September 1, 2017, 17:00 hours through 19:00 hours. Emissions Event 5 is defined as September 3, 2017, 15:40 hours through 17:40 hours. The time period during the emissions events is defined as the six (6) day period encompassing all five (5) emissions events (August 29, 2017, through September 3, 2017).

² PM_{2.5} monitoring data was not available during the time period of Emissions Event 2.

**Table 6-9. Monitored VOC Concentrations during the Crosby Plant Emissions Events
(Wallisville Road, HRM Network, Monitor)**

Constituent ¹	CAS No.	Maximum Monitored Concentration During Crosby Plant Emissions Events ^{2,3} (ppb)			Average Monitored Concentration During Crosby Plant Emissions Events ² (ppb)	AMCV (ppb)	ESL (ppb)
		Event 1	Event 4	Event 5		ST	ST
Isobutane	75-28-5	N/A	6.2	6.9	12.9	33,000	9,700
Isobutene	115-11-7	N/A	0.3	0.14	1.0	270,000	78,000
Ethylbenzene	100-41-4	--	N/A	N/A	1.3	20,000	6,000
Xylenes	1330-20-7	--	N/A	N/A	8.5	--	510
1,2,4-Trimethylbenzene	95-63-6	--	N/A	N/A	6.6	3,000	890

¹ Data is provided for any speciated VOC evaluated by the HRM Network Wallisville Road Monitor that is emitted during the Crosby Plant emissions events.

² Emissions Event 1 is defined as August 29, 2017, 12:00 hours through 18:06 hours. Emissions Event 4 is defined as September 2, 2017, 14:17 hours through September 3, 2017, 0:00 hours. Emissions Event 5 is defined as September 3, 2017, 15:40 hours through 17:40 hours. The time period during the emissions events is defined as the six (6) day period encompassing all five (5) emissions events (August 29, 2017, through September 3, 2017).

³ If a monitored concentration is listed as N/A, this means that the specific VOC is not emitted during that emissions event. If a monitored concentration is given as dashes, this means that monitoring data is not available during the time period of the emissions event.

7. ELECTRONIC FILES

All of the air quality dispersion modeling analysis electronic data files used to generate the results presented in this report are provided in the accompanying electronic file folders. These electronic data files include the following:

- > All AERMOD input, output, and plot data files;
- > All downwash input and output files;
- > Meteorological files, including AERMET, AERMINUTE, and surface and profile data;
- > Toxchem modeling files;
- > Spreadsheet showing all modeling results with comparisons to the applicable standards;
- > Spreadsheet showing all raw background monitored concentration data; and
- > Electronic copy of the modeling report.

The following tables summarize the electronic files.

Table 7-1. Summary of Files

File Name	File Description
01_AERMOD Input and Output Files	See Table 7-2 for a detailed description of contents.
02_Meteorological Files	AERMET and AERMINUTE files. See Table 7-3 for a detailed description of meteorological files used in AERMOD models.
03_BPIP	BPIP (Downwash) input and output files
04_AERSURFACE	AERSURFACE input and output files
05_Tochem	Toxchem modeling files
Model Results	Modeling results compared to applicable standards
Background Concentration Workbook	Worksheet showing raw background monitor data
FINAL Crosby EE Modeling Report	Modeling report

Table 7-2. AERMOD Input and Output File Descriptions for the Air Quality Dispersion Modeling Analysis

Emissions Event	File Name	Associated Files	File Description	Receptor Grid
1	Event 1.zip	Input File (*.ami) Output File (*.ami) Plot File (*.plt) Receptors File (*.ROU)	Unit Emission Rate Modeling	Tight, Fine, Medium, and Coarse grids
2	Event 2.zip			
3	Event 3.zip			
4	Event 4.zip			
5	Event 5.zip			

Table 7-3. Meteorological Files Used for the Air Quality Dispersion Modeling Analysis

Level	Meteorological File Name	Time Period
Surface	WALLISVILLE_ARKEMALU_HgtShift_NoADJU.SFC	8/28/2017-9/4/2017
Profile/Upper Air	WALLISVILLE_ARKEMALU_HgtShift_NoADJU.PFL	8/28/2017-9/4/2017

APPENDIX A: TCEQ MODELING REQUEST

Bryan W. Shaw, Ph.D., P.E., *Chairman*
Toby Baker, *Commissioner*
Jon Niermann, *Commissioner*
Richard A. Hyde, P.E., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

September 26, 2017

CERTIFIED MAIL #91 7199 9991 7033 3049 0328
ELECTRONIC RETURN RECEIPT REQUESTED

Mr. Leslie Comardelle, Plant Manager
Arkema Inc.
18000 Crosby Eastgate Road
Crosby, Texas 77532

Re: Additional Information Request for:
Arkema Crosby Plant, 18000 Crosby Eastgate Road, Crosby (Harris County), Texas
Regulated Entity No.: 100-210-301, Incident Nos.: 266756, 266771, 266778, 267578,
267679, Investigation No.: 1438846

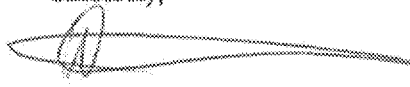
Dear Mr. Comardelle:

The Texas Commission on Environmental Quality (TCEQ) Houston Regional Office has received the Final Records of the following emissions events: Consolidated Compliance and Enforcement Data System (CCEDS) Incident Nos.: 266756, 266771, 266778, 267578, 267679. In order to complete our review, we are requesting air dispersion modeling to show off-property impacts from the emissions of all pollutants which were released from the plant as a result of these events. This information is being requested pursuant to 30 TEX. ADMIN. CODE § 101.201(f) which states that "the owner or operator of a facility experiencing an emissions event must provide, in writing, additional or more detailed information on the emissions event when requested by the executive director . . . within the time frames established in the request." Please provide this information by October 16, 2017.

The Texas Commission on Environmental Quality appreciates your assistance in this matter. Upon our review of the information submitted, we will determine whether the emissions events noted above are excessive under 30 TEX. ADMIN. CODE § 101.222(a). We will notify you of our determination and whether you will need to take additional actions to reduce emissions.

If you or members of your staff have any questions, please feel free to contact Mr. Jason Holloman in the Houston Regional Office at (713) 767-3553. For modeling related questions, please feel free to contact the Air Dispersion Modeling Team, at (512) 239-1250.

Sincerely,


Warda Omar, Air Section Team Leader
Houston Region

cc: Ms. Carolyn Hervey, Environmental Engineer, Arkema Crosby Plant, 18000 Crosby
Eastgate Road, Crosby, Texas 77532

Enclosure: Modeling Checklist

TCEQ Region 12 • 5425 Polk St., Ste. H • Houston, Texas 77023-1452 • 713-767-3500 • Fax 713-767-3520

Austin Headquarters: 512-239-1000 • tceq.texas.gov • How is our customer service? tceq.texas.gov/customersurvey

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Modeling Checklist – Emissions Events

If an impacts evaluation is requested for an emissions event, an air quality analysis should be conducted for the unauthorized emissions. This demonstration is compared to the applicable AMCVs/ESLs, state property line standards, and NAAQS. The air quality analysis in support of an emissions event should include the items below, as appropriate.

Please note if a modeling demonstration is requested of a company, the company must provide all electronic modeling files and the air quality analysis (AQA) to the investigator. This information should then be sent to Dianne Anderson (Dianne.Anderson@tceq.texas.gov) to be assigned and reviewed by the Air Dispersion Modeling Team (ADMT). All electronic files and AQA must be provided in order for ADMT to begin their review.

For large files, a company can either send files via FTP or in the mail on a CD or USB Drive to:

Dianne Anderson
Texas Commission on Environmental Quality
Air Permits Division
12100 Park 35 Circle, Bldg. C
MC-163
Austin, TX 78753

Project Identification Information

- Provide the following information to clearly identify the analysis:
 - Regulated Entity
 - Facility
 - Incident Number
 - Permit Number, as applicable
 - Regulated Entity Number
 - Customer Reference Number
 - Nearest City and County

Project Overview

- Include a brief discussion of the event (reason for the review), duration of the event, and types and locations of emissions under

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consideration.

Constituents Evaluated

- List all constituents that were evaluated. Be sure to provide all relevant information for each constituent evaluated (standard/AMCV/ESL, CAS number, etc.).
- For health effects analyses, compare model results to AMCVs, if available. Otherwise, compare results to appropriate ESL.

Plot Plan

- Depending on the scope of the project, several plot plans may be needed to present all requested information.
- Provide a plot plan that includes:
 - A clearly marked scale.
 - All property lines.
 - A true-north arrow.
 - UTM coordinates along the vertical and horizontal borders. Please do not use plant or other coordinates.
 - Include the datum of your coordinates.
 - Reference UTM coordinates and locations of all emission points including fugitive sources modeled.
 - Labels/IDs and coordinates for emission points on the plot plan should correlate with the information contained in the air quality analysis.
 - Buildings and structures on-property or off-property which could cause downwash. Include length, width, and height.

Area Map

- Include an area map with the air quality analysis. The map should cover the area within a 1.9-mile (3-kilometer) radius of the facility if used for the Auer land-use analysis.
- The area map should include all property lines. For sites with a single property line designation (SPLD), include all property lines associated with the SPLD. Also include a copy of the SPLD petition with the air quality analysis.
- Add UTMs to the horizontal and vertical dimensions of the map section, as well as the date and title of the map. Include the datum of your coordinates.

Modeling Emissions Inventory

- On-Property Sources to be evaluated,
 - Include all source parameters and emissions rates associated with the event, preferably in table format.
 - Identify special source types or characterizations such as covered stacks, horizontal exhausts, fugitive sources, area sources, open pit sources, volume sources, roads, stockpiles, and flares.
 - Include all assumptions and calculations used to determine as appropriate the size, sides, rotation angles, heights of release, initial dispersion coefficients, effective stack diameter, gross heat release and weighted (by volume) average molecular weight of the mixture being burned.
 - Specify particulate emissions as a function of particle size; mass fraction for each particle size category; and particle density for each particle size category, as applicable.

Table Correlating the Emission Inventory Source Name and EPN with the Source Number in the Modeling Output

- Include a table that cross-references the source identification numbers used in the modeling if they are different from the emission point numbers in the permitted Maximum Allowable Emission Rate Table (MAERT) or from any additional list of sources.

Stack Parameter Justification

- Include the basis for using the listed stack parameters (flow rates, temperatures, stack heights, velocities). This should include the calculations used to determine the parameters.

Scaling Factors

- Discuss how emission scalars were developed and used in the modeling demonstration.

Models Proposed and Modeling Techniques

- Include a detailed discussion of the models that were used, model version numbers, and the model entry data options such as the regulatory default option and the period option.
- Discuss any specialized modeling techniques such as screening, collocating sources, and ratioing.
- Include assumptions and sample calculations.

Selection of Dispersion Option

- Base the selection of urban or rural dispersion coefficients on the Auer land-use analysis.
- Include a detailed discussion and sufficient technical justification to support the selection of the dispersion option.

Building Wake Effects (Downwash)

- Discuss how downwash structures were determined and include applicable information required to use the EPA's BPIP-PRIME. Submit all input files and files generated by the BPIP-PRIME program, and any computer assisted drawing files.
- Provide a table of structure heights used in the downwash analysis.

Receptor Grid

- Discuss how the receptor grids were determined for each type of analysis.
- Include the datum of your coordinates.
- Discuss if terrain was applicable. If so, discuss how terrain for individual receptors was determined.

Meteorological Data

- Indicate the surface station, surface station anemometer height, surface station profile base elevation, upper-air station, and period of record, as applicable.
- Include the meteorological data files used for all demonstrations.
- Discuss how meteorological data were determined or replaced. Include ADMT approval of replacement data.
- In addition, submit all the supplementary data used to develop the specific input meteorological parameters required by the meteorological pre-processor programs.

Modeling Results

- Summarize and compare the modeling results relative to all applicable AMCVs (ESL if an AMCV does not exist), state property line standards, and NAAQS. Tabulated results are preferred.

Digital Information (Model Input/Output and Associated Computer or Electronic Files)

- Include:

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- All input and output files for each dispersion model run, including data, grid and plot files.
- All files produced by a software entry program.
- All automated downwash program input and output files and any computer assisted drawing files.
- All meteorological data files in ASCII format. If meteorological data will be processed for the emission event period, include all meteorological data preprocessor input and output files. Be sure to include full documentation and the supporting technical justification for the processing of the meteorological data.
- All boundary files, including computer assisted drawing files, specifying coordinates for property lines.
- Include all spreadsheet files used for comparison of predicted concentrations with standards or guidelines. This includes, but is not limited to, spreadsheet files used for ratio techniques.

APPENDIX B: EMISSION CALCULATIONS

Arkema Inc. - Crosby
Tank 2A 2B Overflow Emissions
August 29, 2017

Emission Estimate of Waste Water Tank Overflow

There are two waste water tanks (2A and 2B) used to treat wastewater containing mineral spirits. Tanks were almost full (98%-99%) and an organic layer was on the top of each tank when heavy rains caused the tanks to overflow. When organic layer is spilled on the ground, it spreads out, vaporizes, and results in air emissions.

Tank 2A: The tank was measured with a 6 inch organic layer prior to the overflow and 1/4 inch after the overflow. The tank has a diameter of 35 ft. the volume of overflow is based on the net volume of the organic layer before and after the overflow.

Tank 2B: Measurements are not available for the organic layer; however, an estimate of the volume of organics was based on typical waste water organics generation. After reviewing the past four 90-day disposals of waste water organics, the daily average waste water organics generation from the process units is 45 gal/day. For conservatism, it is assumed that 2 days-worth of production organics (90 gallons) were in tank 2B at the time of the overflow.

Density of Mineral Spirits [1]	6.67	lb/gal
Tank 2A Diameter [2]	35	ft
Thickness of Organic Layer [2]	0.48	ft
Organics Overflow from Tank 2A [2]	3,448.37	gal
	23,007.54	lb
Organics Overflow from Tank 2B [3]	90.00	gal
	600.48	lb

Component [4]	Min wt% [4]	Max wt% [4]	Normalized wt% [4]	Total Organic Spilled from Tank 2A	Total Organic Spilled from Tank 2B	Total Organic Spilled from Tanks	Total Organic Spilled from Tanks Normalized
				lb/event	lb/event	lb/event	wt%
T-Amyl Alcohol	0%	20%	8.58%	1,974.90	51.54	2,026.44	5.13E-06
T-Butyl Alcohol	0%	20%	8.58%	1,974.90	51.54	2,026.44	5.13E-06
Di-T-Butyl Peroxide	0%	5%	2.15%	493.72	12.89	506.61	1.28E-06
Di-T-Amyl Peroxide	0%	5%	2.15%	493.72	12.89	506.61	1.28E-06
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	0%	5%	2.15%	493.72	12.89	506.61	1.28E-06
Ethyl Benzene	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
Naphthalene (Crude Or Refined)	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
1, 2, 4 - Trimethylbenzene	4%	22%	9.44%	2,172.39	56.70	2,229.08	5.64E-06
Hydrotreated Heavy Naphtha	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
Water [5]	0%	0%	--	--	--	395,234,134.55	1.00E+00
Mineral Spirits	0%	80%	34.33%	7,899.58	206.17	8,105.76	2.05E-05
Naphtha, light aromatic	28%	60%	25.75%	5,924.69	154.63	6,079.32	1.54E-05
Xylene, mixed isomers	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
Total Active Oxygen from Organic Peroxides [6]	0%	0%	--	--	--	--	--

Notes:

[1] According to "Waste Water Organics (with OMS Diluent) In House Profile.pdf" provided by Arkema, specific gravity is 0.7-0.9. Average specific gravity 0.8 is used in the calculation.

[2] Provided by Arkema based on tank diameter and measurement of organic layer prior to and after overflow.

[3] Provided by Arkema based on the best estimate assuming typical daily production and two days of production.

[4] Per "Waste Water Organics (with OMS Diluent) In House Profile.pdf" and "Waste Profile for Wastewater Organics with Mineral Spirits (Signed 11-18-14).pdf" provided by Arkema, wt% of components are normalized based on the maximum wt% of each possible component in wastewater.

[5] Weight percentage of water is changed from maximum 10% to 0% to be conservative. For total event normalized concentrations, the volume of water includes the estimated volume of stormwater flow through the spill area over the event period (i.e., Estimated 1 mph stormwater flow across area of 1.55 m x 100 m over 6 hours).

[6] Weight percentage of total active oxygen from organic peroxides is changed from 1% to 0% to be conservative.

Arkema Inc. - Crosby
Tank 2A 2B Overflow Emissions
August 29, 2017

Tank Overflow Emissions Based on Toxchem Modeled Results

Compound [1]	CAS No.	Maximum Wastewater Tank Concentration [2] (ppm)	Total Emissions [3] (lb/event)	Emissions from Flooded Area [4] (lb/hr)
T-Amyl Alcohol	75-85-4	5.13	42.85	7.14
T-Butyl Alcohol	75-65-0	5.13	8.85	1.48
Di-T-Butyl Peroxide	110-05-4	1.28	37.30	6.22
Di-T-Amyl Peroxide	10508-09-5	1.28	22.51	3.75
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	78-63-7	1.28	2.18	0.36
Ethyl Benzene	100-41-4	1.03	35.92	5.99
Naphthalene (Crude Or Refined)	91-20-3	1.03	31.27	5.21
1, 2, 4 - Trimethylbenzene	95-63-6	5.64	165.37	27.56
Hydrotreated Heavy Naphtha	64742-48-9	1.03	31.27	5.21
Mineral Spirits	--	20.51	231.84	38.64
Naphtha, light aromatic	64742-95-6	15.38	514.98	85.83
Xylene, mixed isomers	1330-20-7	1.03	37.44	6.24
VOC Totals (lbs/event):			1,161.79	--
VOC Totals (tons/event):			0.58	--

¹ Hydrotreated heavy naphtha was modeled as naphthalene, mineral spirits was modeled as decane, and light naphtha was modeled as pentane.

² Wastewater tank concentrations based on normalized wastewater organics composition.

³ The emission event occurred from noon to 6 PM on August 29, 2017; therefore, multiplied the hourly emissions by six (6) to determine the overall emissions for the event for each chemical compound.

⁴ Hourly Emissions (lb/hr) = Toxchem Modeled Results (g/day) * 1/24 (day/hours) * 1/453.59 (lb/g)

Arkema Inc. - Crosby
Tank 2A 2B Overflow Emissions
August 29, 2017

Tank Overflow Unit Parameters

Influent Stream

Flow Rate [1]	1,097,872.60	gpm(US)	
Suspended Solids	200	ppm	Toxchem Default
VSS to SS Ratio	100	%	Conservative assumption
Wastewater DOC	0	ppm	Toxchem Default
Oil/Grease Concentration	0	ppm	Toxchem Default
Temperature [2]	71.8	deg F	
	22	deg C	Unit Conversion

Lagoon (Polishing Pond)

Liquid Depth [3]	1.55	m	
Surface Area [4]	40,000.00	m ²	
Effluent SS Concentration	200	ppm	Assume no change

Site Parameters

Elevation [5]	14.00	m	
Wind Speed [2]	17.13	mph	
Site Wide pH	7		Toxchem Default

[1] Flow based on estimated quantity of wastewater organics overflowing the tank divided by the estimated duration of the event.

[2] Temperature and wind speed from the Wallisville Road C617 (EPA Site No. 48-201-0617) monitoring site (https://www.tceq.texas.gov/cgi-bin/compliance/monops/yearly_summary.pl), accessed October 17, 2017. Maximum temperature was calculated from 12:00 PM to 6:00 PM on August 29, 2017.

[3] Liquid depth based on difference in elevation between tanks and property line at drainage point.

[4] Surface area of lagoon represented to be 100 meters by 400 meters based on flow path from tank overflows to property line.

[5] Elevation was determined using National Elevation Data (NED) obtained from the United States Geological Survey (USGS).

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

Emissions Summary

Emission Source	Emissions (lb/event)								
	CO	NO _x	PM	PM ₁₀	PM _{2.5}	SO ₂	VOC	HF	Lead
Products in Trailer No. 1 Consumed in Fire	511.17	59.62	176.71	176.71	176.71	--	4,751.74	--	--
Trailer Consumed in Fire	484.38	15.50	387.50	387.50	387.50	--	124.00	--	--
Pallets Consumed in Fire	133.50	4.27	106.80	106.80	106.80	--	34.18	--	--
Containers Consumed in Fire	342.90	10.97	274.32	274.32	274.32	--	87.78	--	--
Refrigeration Unit Consumed in Fire	61.72	1.98	49.38	49.38	49.38	--	15.80	--	--
Refrigerant Consumed in Fire	--	--	--	--	--	--	--	3.28	--
Battery Consumed in Fire	--	--	5.37	5.37	5.37	9.79	--	--	1.82
Diesel Fuel Consumed in Fire	0.13	0.60	0.08	0.08	0.08	1.78	0.01	--	--
Total Emissions	1,533.79	92.94	1,000.16	1,000.16	1,000.16	11.56	5,013.50	3.28	1.82

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Nonane	111-84-2	56703	1,297.43
Nonene	124-11-8	56704	427.13
OMS	68551-17-7	59275	1,069.31
Acetophenone	98-86-2	59061	805.93
2-Ethyl hexanol	104-76-7	51521	869.00
2-Ethyl hexanal	123-05-7	51601	282.94
Acetone	67-64-1	54020	393.76
Ethane	74-84-0	56550	38.32
Hydrofluoric Acid	7664-39-3	11162	3.28
Lead	7439-92-1	14319	1.82
CO	630-08-0	90300	1,533.79
NO _x	10102-44-0	70402	92.94
PM	--	10000	1,000.16
PM ₁₀	--	20000	1,000.16
PM _{2.5}	--	39999	1,000.16
SO ₂	7446-09-5	70510	11.56
Unclassified VOC [1]	--	500001	261.76

Note:

[1] Unclassified VOC includes VOC emissions from combustion products.

Summary of Emissions from Trailer 1

Emission Source	Emissions (lb/event)					
	VOC	CO	NO _x	PM	PM ₁₀	PM _{2.5}
Decomposition to Vapor - Unburned	1,006.37	---	---	---	---	---
Decomposition Products - Burned	3,743.37	511.17	59.62	176.71	176.71	176.71
Total	4,751.74	511.17	59.62	176.71	176.71	176.71

1. Emissions from Decomposition to Vapor - Unburned

A. Emissions from Decomposition to Vapor - Unburned					
Product	Decomp Composition [1]	Vapor wt% [2]	Decomp to Vapor, Unburned - Total lbs	Decomp to Vapor, Unburned - Speciated lbs	Speciated VOC Emissions to Air lbs
Lup 188M/5	Nonane	23.44%	1,181.25	276.93	276.93
	Nonene	2.74%		91.48	91.48
	Carbon Dioxide	10.73%		126.70	
	OMS	24.99%		294.06	294.06
	Acetophenene	29.28%		345.69	345.69
	Methane	3.91%		46.19	
Total VOC from Vapor (Unburned) to Air					1,008.37

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

2. Emissions from Decomposition Products - Burned
VOC Emissions

Product	Original Composition [4]	Original wt% [4]	Decomposed Composition [1]	Decomposed wt% [2]	Product Unburned - Total [5] lbs	Destruction Efficiency 93% [3]		Heating Value [6] btu/lb	Heat Input MMBtu	Speciated VOC Emissions to Air lbs
						Speciated Emissions to Air lbs	Product Burned - Total [5] lbs			
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>=95%	Nonane	37%	55.1	205.62	2,731.81	19,000	51.90	205.62
	Hydroperoxides, 1,1-dimethylethyl	<1%	Nonene	12%		67.46	996.29	18,900	16.85	67.46
			Carbon Dioxide	22%		119.73	1,590.73	0	0.00	
			OMS	0%		0.00	0.00	15,000	0.00	0.00
			Acetone	23%		124.14	1,649.32	12,281	20.25	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>=74 - <=76%	Nonane	29%	1,103	323.90	4,304.26	19,000	61.78	323.90
	Naphtha (petroleum), hydrotreated heavy	<26%	Nonene	10%		106.29	1,412.20	18,900	26.55	106.29
	Naphtha (petroleum), heavy alkylate	<26%	Carbon Dioxide	13%		148.22	1,969.25	0	0.00	
	Hydroperoxides, 1,1-dimethylethyl	<0.2%	OMS	75%		774.37	3,645.76	15,000	54.68	774.37
			Acetone	18%		195.60	2,598.08	12,281	31.91	
Lup 189M75	Neodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	>=74 - <75%	Nonane	23%	1,571	368.32	4,893.34	19,000	92.97	368.32
	Benzononmethanol, alpha, alpha-dimethyl-	>=5 - <=11%	Nonene	8%		121.67	1,616.46	18,800	30.39	121.67
	Benzene (1-methylethyl)-	>=5 - <=7%	Carbon Dioxide	11%		168.51	2,238.76	0	0.00	
	Ethanol, 1-phenyl-	<=5%	OMS	25%		391.10	5,196.08	15,000	77.94	391.10
	Naphtha (petroleum), hydrotreated heavy alkylate	>=1 - <25%	Acetophenone	29%		460.04	6,111.95	14,257	67.14	460.04
Lup 223M75S	Peroxydicarbenic acid, bis(2-ethylhexyl)-	>=75 - <=77%	2-Ethyl hexanol	56%	1,544	869.00	11,545.73	15,000	173.18	869.00
	Naphtha (petroleum), hydrotreated heavy	<25%	2-Ethyl hexanol	18%		282.94	3,759.05	15,000	56.39	282.94
	Naphtha (petroleum), heavy alkylate	<25%	Carbon Dioxide	25%		391.56	5,202.22	0	0.00	
	Proprietary component	<0.2%								
Lup 546M75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>=74 - <=75%	Nonane	28%	441	122.59	1,628.69	19,000	30.95	122.59
	Naphtha (petroleum), hydrotreated heavy	>=0 - <=25%	Nonene	9%		40.22	534.36	18,800	10.05	40.22
	Naphtha (petroleum), heavy alkylate	>=0 - <=25%	Carbon Dioxide	13%		56.09	745.15	0	0.00	
	Hydroperoxides, 1,1-dimethylpropyl	<=0.1%	OMS	25%		109.77	1,458.36	15,000	21.88	109.77
			Acetone	17%		74.01	983.52	12,281	12.08	
Totals:									930.07	3,743.37

NOx, CO, and PM Emissions

Pollutants	Emission Factors	
	lb/MMBtu	lb/oz/oz
NOx [7]	0.0641	59.62
CO [7]	0.5496	511.17
PM [8]	0.19	176.71

Notes

- [1] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx". "OMS" stands for
- [2] Calculated based on 1000 pounds of Lup 189M75 product decomposed, provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".
- [3] Per TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES, based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency (DRE) is assumed.
- [4] Product composition provided by Arkema via email on 5/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
- [5] According to Arkema, 5% as Lup 189M75 was emitted as vapor prior to combustion. The remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).
- [6] Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds/Enthalpy of Combustion
- [7] TCEQ publication RG-360A/11, Revised January 2017, TECHNICAL SUPPLEMENT 4: FLARES, Table A-7, air or unassisted flare, low btu.
- [8] Based on AP 42 Table 13.5-1, heavily smoking flares 274 µg/L in exhaust, calculated from concentration using F-factor method on a dry basis, assuming 3% O₂ in exhaust gas stream (Emission Estimation Protocol for Petroleum Refineries, RTI International, May 2011, Table 6-4)

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

Summary of Emissions from Trailer Components Combustion

Emission Source	Emissions (lb/event)					
	VOC	CO	NO _x	PM	PM ₁₀	PM _{2.5}
Combustion Emissions	261.76	1,022.49	32.72	818.00	818.00	818.00

Trailers		
Weight of Trailer [1]	15,500	pounds
Burned [2]	50%	
Weight of Trailer Burned	7,750	pounds
Pallets		
Weight of Each Pallet [3]	44.5	pounds
# of Pallets in a Trailer [4]	48	
Burned	100%	
Weight of Pallets Burned	2,136	pounds
Containers		
Weight of a 5 Gal Container [5]	1,153	grams
Weight of a 5 Gal Container	2.54	pounds
Trailer Capacity	3,500	ft ³
Number of 5 Gal Containers Impacted [5]	2,160	
Burned	100%	
Weight of Containers in a Trailer	5,486	pounds
Refrigeration Unit		
Weight of Refrigeration Unit [6]	1,975	pounds
Burned	50%	
Weight of Refrigeration Unit Burned	988	pounds
Total Weight of Solid Combustibles Per Trailer	8.18	tons

Refrigerant

Weight of Refrigerant [6]	16	pounds		
Compositions [7]	CAS #	M. Wt.	Wt%	Emissions
		lb/lb-mol		lbs
1,1,1-Trifluoroethane [7]	420-46-2	84.04	52%	8.32
Pentafluoroethane [7]	354-33-6	120.02	44%	7.04
1,1,1,2-Tetrafluoroethane [7]	811-97-2	102.03	4%	0.64
Emissions as Hydrofluoric Acid (HF)	7664-39-3	20.01		3.28

Battery

Weight of Battery [8]		50 pounds		
Compositions [9]	CAS #	M. Wt.	Wt%	Weight
		lb/lb-mol		lbs
Lead	7439-92-1	207.2	70%	35
Sulfuric acid	7664-93-9	98.08	30%	15

Emissions from Battery Burned

Pollutant	Emission Factor [10]	Emissions from Lead Burned	Emissions from Sulfuric Acid Burned [11]
	lb of pollutant/ton of metal produced	lbs	lbs
PM	307	5.37	--
Lead	104	1.82	--
SO ₂	--	--	9.79

NO_x, CO, and PM Emissions from Trailer Components Combustion

Pollutants	Emission Factors [12]	Emissions From Trailer Burning	Emissions From Pallets Burning	Emissions From Containers Burning	Emissions From Refrigeration Unit Burning	Total Emissions From Solids Burning
	lb/ton	lbs	lbs	lbs	lbs	lbs
VOC	32	124.00	34.18	67.78	15.80	261.76
NO _x	4	15.50	4.27	10.97	1.98	32.72
CO	125	484.38	133.50	342.90	61.72	1,022.49
PM	100	397.50	106.80	274.32	49.38	818.00

Notes:

- [1] Per information provided by Arkema, the trailer is a 53' refrigerated trailer, based on vendor information, typical weight of refrigerated trailer is 15,500 lb.
- [2] Based on phone communication between Arkema and Trinity Consultants on September 6, 2017, 50% of weight of trailer estimated to be combusted.
- [3] According to dimensions of trailer provided by Arkema, typical pallet used in this type of trailer is 40"x48" and weight is 44.5 lb.
- [4] Provided by Arkema based on trailer inventory and products information.
- [5] Provided by Arkema based on trailer inventory and products information, typical 35 lbs products per container. Typical empty container weight based on vendor information.
- [6] Weight of refrigeration unit and refrigerant based on vendor information for typical unit.
- [7] Per R-404A Refrigerant safety data sheet (SDS)
- [8] Per KLLM Trailer Specifications
- [9] Per Lead-acid Battery SDS normalized to total weight of battery for conservatism.
- [10] The battery in engine of trailer burned in the fire and is represented as second lead processing in blast furnaces. Particulate and lead emission factors are selected based on AP-42 Chapter 12.11.2, Table 12.11-2, Emission Factors for Secondary Lead Processing.
- [11] Sulfur dioxide (SO₂) emissions estimated assuming all sulfur from sulfuric acid converted to SO₂.
- [12] Emission factors from AP-42 Chapter 2.5, Table 2.5-1 "Emission Factors for Open Burning of Municipal Refuse," factors for Automobile Components

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

Products in Trailer No. 1

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in 1st Trailer [2]
				lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	(b) (3) (A), (b) (4)
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <=76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneperoxoic acid, 2,2-dimethyl-, 1,1-dimethylethyl ester	927-07-1	>=44- <46%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneperoxoic acid, 2,2-dimethyl-, 1,1-dimethylethyl ester	927-07-1	>=74- <76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Neodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	
	Benzene:methanol, alpha., alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5- <=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
Total (lbs)				75,600

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

Estimate Pounds of Material Lost in Fire
Destruction Efficiency [4]

Products in Trailers	Quantity [1]	93%						
	lbs	% Fast Decomp - to Vapor [3]	% Decomp to Fire Unburned [4]	% Decomp to Fire Burned [4]	% Burned from Original Product [5]	lb Decomp to Vapor	lb Decomp to Fire, Unburned	lb Decomp to Fire, Burned
Lup 10	(b) (3) (A), (b) (4)	--	7%	93%	0%	--	551	7,323.75
Lup 10M75		--	7%	93%	0%	--	1,102.50	14,647.50
Lup 11M45		--	7%	93%	0%	--	--	--
Lup 11M75		--	7%	93%	0%	--	--	--
Lup 188M75		5%	6.65%	88.35%	0%	1,181.25	1,571.06	20,872.69
Lup 221		--	7%	93%	0%	--	--	--
Lup 223M75S		--	7%	93%	0%	--	1,543.50	20,506.50
Lup 223S		--	7%	93%	0%	--	--	--
Lup 223V75		--	7%	93%	0%	--	--	--
Lup 225M60		--	7%	93%	0%	--	--	--
Lup 546M75		--	7%	93%	0%	--	441.00	5,859.00
Total	75,600					1,181.25	5,209.31	69,209.44

Notes:

[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".

[2] Provided by Arkema via email on 9/3/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

[3] Based on the information provided by Arkema, 5% of Lup 188M75 is used to represent the decomposition products to vapor phase.

[4] Per TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES, based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency is assumed. Therefore, for decomposed product Lup 188M75 remaining after vapor release, 7% unburned, and 93% of decomposed part is burned.

[5] Value excludes diluent (e.g., naphtha).

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

Input

Parameter	Value	Units
Diesel Oil Burned [1]	25	gal/event

¹ Volume combusted based on email from Arkema, September 7, 2017.

Emission Factors and Emissions of Criteria Pollutants

Pollutant	Emission Factor [1] [2] (lb/Mgal)	Emissions (lb/event) (short tons/event)	
CO	5	0.13	6.3E-05
NO _x	24	0.60	3.0E-04
PM	3.3	0.08	4.1E-05
PM ₁₀	3.3	0.08	4.1E-05
PM _{2.5}	3.3	0.08	4.1E-05
SO ₂	71	1.78	8.9E-04
VOC	0.2	0.01	2.5E-06

Note:

[1] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Tables 1.3-1 and 1.3-2 - No. 2 oil fired (1-01-005-01), (1-02-005-01), (1-03-005-01) for CO, NO_x, PM, PM₁₀, PM_{2.5}, and SO₂.

[2] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Table 1.3-3 - Industrial boilers, Distillate oil fired (1-02-005-01/02/03) for VOC.

Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017

Emissions Summary

Emission Source	Emissions (lb/event)								
	CO	NO _x	PM	PM ₁₀	PM _{2.5}	SO ₂	VOC	HF	Lead
Products in Trailer No. 2 and 3 Consumed in Fire	479.95	55.98	165.92	165.92	165.92	--	3,977.20	--	--
Trailer Consumed in Fire	968.75	31.00	775.00	775.00	775.00	--	248.00	--	--
Pallets Consumed in Fire	122.38	3.92	97.90	97.90	97.90	--	31.33	--	--
Containers Consumed in Fire	314.33	10.06	251.46	251.46	251.46	--	80.47	--	--
Refrigeration Unit in Fire	123.44	3.95	98.75	98.75	98.75	--	31.60	--	--
Refrigerant Consumed in Fire	--	--	--	--	--	--	--	6.56	--
Battery Consumed in Fire	--	--	10.75	10.75	10.75	19.58	--	--	3.64
Diesel Fuel Combusted in Fire	0.25	1.20	0.17	0.17	0.17	3.55	0.01	--	--
Total Emissions	2,009.09	106.10	1,399.94	1,399.94	1,399.94	23.13	4,368.61	6.56	3.64

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Nonane	111-84-2	56703	1,424.49
Nonene	124-11-8	56704	1,226.90
OMS	68551-17-7	59275	527.99
Acetophenone	98-86-2	59861	249.37
2-Ethyl hexanol	104-76-7	51521	89.87
2-Ethyl hexanal	123-05-7	51601	89.87
Acetone	67-64-1	54020	430.36
Ethane	74-84-0	56550	223.75
Hydrofluoric Acid	7664-39-3	11162	6.56
Lead	7439-92-1	14319	3.64
CO	630-08-0	90300	2,009.09
NO _x	10102-44-0	70402	106.10
PM	--	10000	1,399.94
PM ₁₀	--	20000	1,399.94
PM _{2.5}	--	39999	1,399.94
SO ₂	7446-09-5	70510	23.13
Unclassified VOC [1]	--	500001	391.41

Note:

[1] Unclassified VOC includes VOC emissions from combustion products.

Summary of Emissions from Trailer 2 and Trailer 3

Emission Source	Emissions (lb./event)				
	VOC	CO	NO _x	PM	PM ₁₀
Decomposition to Vapor - Unburned	737.85	-	-	-	-
Decomposition Product - Burned	3,144.35	479.95	52.50	165.92	165.92
Total	3,977.20	479.95	52.50	165.92	165.92

1. Emissions from Decomposition to Vapor - Unburned

Product	Decomp Composition [1]	Vapor wt% [2]	Decomp to	Decomp to	Speciated VOC
			Vapor, Unburned - Total	Vapor, Unburned - Speciated	Emissions to Air
Lap 10	Nonane	37.37%	393.75	146.37	146.37
	Nonene	12.74%		48.19	48.19
	Carbon Dioxide	41.73%		85.52	0
	CH ₄	0.00%		0	0
	Acetone	22.52%		88.67	88.67
	Methane	5.64%		24.49	24.49
Lap 198M75	Nonane	23.49%	536.06	147.73	147.73
	Nonene	7.74%		48.79	48.79
	Carbon Dioxide	51.73%		67.57	0
	CH ₄	24.39%		136.83	136.83
	Acetone	20.33%		138.40	138.40
	Methane	3.91%		24.53	24.53
Total VOC from Vapor (Unburned) to Air					737.85

**Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017**

2. Emissions from Decomposition Products - Burned

VOC Emissions

Product	Original Composition [4]	Original wt% [4]	Decomposed Composition [1]	Decomposed wt% [2]	Product Unburned - Total [5] lbs	Decomposition Efficiency 94% [3]		Heating Value [6] Btu/lb	Heat Input MMbtu	Speciated VOC Emissions to Air lbs
						Speciated Emissions to Air lbs	Product Burned - Total [5] lbs			
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>=99%	None	37%	524	195.34	309.66	2,965.22	19,060	49.31
	Hydroperoxide, 1,1-dimethylbutyl-	<1%	None	17%		64.09	851.47	18,800	16.31	64.09
			Carbon Dioxide	22%		113.73	1,511.20	0	0.00	
			SO2	0%		0.36	9.03	15,000	0.00	
			Azotone	23%		117.94	1,566.85	12,281	19.34	0.00
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>=74- <=76%	None	29%	2,045	615.55	8,178.09	19,060	155.38	615.55
	Naphtha (petroleum), hydrotreated heavy	<26%	None	13%		201.96	2,683.18	18,800	50.44	201.96
	Naphtha (petroleum), heavy alkylate	<26%	Carbon Dioxide	13%		281.62	3,741.57	0	0.00	
	Hydroperoxide, 1,1-dimethylbutyl-	<0.2%	OMS	23%		521.31	6,916.00	15,000	103.09	521.31
			Azotone	13%		371.44	4,977.30	12,281	50.44	
Lup 18BM75	Neodecaneperoxoic acid, 1-methoxy-1-phenylethyl ester	>=74- <=75%	None	23%	838	196.44	2,609.78	19,000	49.59	196.44
	Benzene, ethyl-, alpha, alpha-dimethyl-	>=5- <=11%	None	6%		64.89	851.11	18,800	16.21	64.89
	Benzene, (1-methylbutyl-)	>=5- <=7%	Carbon Dioxide	11%		89.07	1,194.00	0	0.00	
	Branched, n-phenyl-	<=0%	OMS	25%		208.55	2,771.34	15,000	41.57	208.55
	Naphtha (petroleum), hydrotreated heavy	>=1- <=23%	Azotophenone	29%		245.35	3,259.71	14,257	46.47	245.35
Lup 22BM75S	Naphtha (petroleum), heavy alkylate	>=1- <=25%	Methane	4%		32.76	435.25	21,505	9.36	
	Peroxydicarbonic acid, tri (2-ethylhexyl)	>=75- <=77%	1-ethyl hexanol	36%	862	496.57	6,597.28	15,000	98.96	496.57
	Naphtha (petroleum), hydrotreated heavy	<25%	2-Diethyl hexanol	18%		161.60	2,140.03	15,000	32.22	161.60
	Naphtha (petroleum), heavy alkylate	<35%	Carbon Dioxide	29%		233.75	2,973.70	0	0.00	
	Proprietary component	<0.2%								
Lup 54BM75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>=74- <=75%	None	28%	441	122.59	1,628.69	19,000	36.95	122.59
	Naphtha (petroleum), hydrotreated heavy	>=0- <=25%	None	6%		40.22	534.36	18,800	10.35	40.22
	Naphtha (petroleum), heavy alkylate	>=0- <=25%	Carbon Dioxide	13%		56.09	745.15	0	0.00	
	Hydroperoxide, 1,1-dimethylpropyl	<=0.1%	OMS	25%		159.77	1,458.36	15,000	31.88	159.77
			Azotone	17%		74.01	983.33	12,281	13.06	
Totals						30.52	509.12	30,458	873.28	3,244.35

NOx, CO and PM Emissions

Pollutants	Emission Factors lb VOC/lb Fuel	Emissions lbs per hour
NOx [7]	0.5641	35.98
CO [7]	0.8498	479.95
PM [9]	0.19	169.93

Notes

- [1] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 081817 Trailers 2 & 3 Bldg.pdf". "OMS" stands for
- [2] Calculated based on 100 percent of Lup 18BM75 product decomposed, provided by Arkema in the file "Crosby Inv 081817 Trailers 2 & 3 Bldg.pdf".
- [3] For TCEQ publication 80-3664/1, Revised February 2012, TECHNICAL SUPPLEMENT 4, TABLES based on EPA test data, for combustion that do not satisfy 40 CFR 60.10, a 90 percent destruction efficiency (DRE) is assumed.
- [4] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 081817 Trailers 2 & 3 Bldg.pdf".
- [5] According to Arkema, 9% of Lup 18 and Lup 18BM75 was emitted as vapor prior to combustion. The remaining product decomposed except diluent (e.g., OMS) and treated with a 94% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).
- [6] Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds/Enthalpy of Combustion
- [7] TCEQ publication 80-3664/1, Revised January 2017, TECHNICAL SUPPLEMENT 4, TABLES, Table A-7, after unadjusted form, see Eqs.
- [8] Based on AP 42 Table 13.5-1, heavily smoldering fires 274 µg/L in exhaust, calculated from concentration using E factor method on a dry basis, assuming 1% O₂ in exhaust gas stream. [Emission Estimation Protocol for Petroleum Refineries, 2011 International, May 2011, Table 6-4].

Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017

Summary of Emissions from Trailer No. 2 and No.3 Components Combustion

Summary of Emissions from Trailer (No. 2 and No. 3) Components Combustion						
Emission Source	Emissions (lb/event)					
	VOC	CO	NO _x	PM	PM ₁₀	PM _{2.5}
Combustion Emissions	391.40	1,528.89	48.92	1,223.11	1,223.11	1,223.11

Trailers		
Weight of a Trailer [1]	15,500	pounds
Number of Trailers Burned	2	
Burned [2]	50%	
Weight of Trailer Burned	15,500	pounds
Pallets		
Weight of Each Pallet [3]	44.5	pounds
# of Pallets in a Trailer [4]	22	
Burned	100%	
Weight of Pallets Burned	1,958	pounds
Containers		
Weight of a 5 Gal Container [5]	1,153	grams
Weight of a 5 Gal Container	2.54	pounds
Trailer Capacity	3,500	ft ³
Number of 5 Gal Containers Impacted [5]	1,980	
Burned	100%	
Weight of Containers in a Trailer	5,029	pounds
Refrigeration Unit		
Weight of a Refrigeration Unit [6]	1,975	pounds
Burned	50%	
Weight of Refrigeration Unit Burned	1,975	pounds
Total Weight of Solid Combustibles Per Trailer	12.23	tons

Refrigerant

Weight of Refrigerant [6]		16 pounds/trailer		
Compositions [7]	CAS #	M. Wt.	Wt%	Emissions
		lb/lb-mol		lbs
1,1,1-Trifluoroethane [7]	420-46-2	84.04	52%	16.64
Pentafluoroethane [7]	354-33-6	120.02	44%	14.08
1,1,1,2-Tetrafluoroethane [7]	811-97-2	102.03	4%	1.28
Emissions as Hydrogen Fluoride	7664-39-3	20.01		6.56

Battery

Weight of Battery [8]	50	pounds/trailer		
Compositions [9]	CAS #	M. Wt.	Wt%	Weight
		lb/lb-mol		lbs
Lead	7439-92-1	207.2	70%	70
Sulfuric acid	7664-93-9	98.08	30%	30

Emissions from Battery Burned

Pollutant	Emission Factor [10]	Emissions from Lead Burned	Emissions from Sulfuric Acid Burned [11]
	lb of pollutant/ton of metal produced	lbs	lbs
PM	3.07	10.75	--
Lead	104	3.64	--
SO ₂	--	--	19.58

NO_x, CO, and PM Emissions from Trailer Components Combustion

Pollutants	Emission Factors [12]	Emissions From Trailer Burning	Emissions From Pallets Burning	Emissions From Containers Burning	Emissions From Refrigeration Unit Burning	Total Emissions From Solids Burning
	lb/ton	lbs	lbs	lbs	lbs	lbs
VOC	32	248.00	31.33	80.47	31.60	391.40
NO _x	4	31.00	3.92	10.06	3.95	48.92
CO	125	968.75	122.38	314.33	123.44	1,528.89
PM	100	775.00	97.90	251.46	96.75	1,223.11

Notes:

- [1] Per information provided by Arkema, the trailer is a 53' refrigerated trailer, based on vendor information, typical weight of refrigerated trailer is 15,500 lb.
- [2] Based on phone communication between Arkema and Trinity Consultants on September 6, 2017, 50% of weight of trailer estimated to be combusted.
- [3] According to dimensions of trailer provided by Arkema, typical pallet used in this type of trailer is 40"x48" and weight is 44.5 lb.
- [4] Provided by Arkema based on trailer inventory and products information.
- [5] Provided by Arkema based on trailer inventory and products information, typical 35 lbs products per container. Typical empty container weight based on vendor information.
- [6] Weight of refrigeration unit and refrigerant based on vendor information for typical unit.
- [7] Per R-404A Refrigerant safety data sheet (SDS)
- [8] Per KLLM Trailer Specifications
- [9] Per Lead-acid Battery SDS normalized to total weight of battery for conservatism.
- [10] The battery in engine of trailer burned in the fire and is represented as second lead processing in blast furnaces. Particulate and lead emission factors are selected based on AP-4.2 Chapter 12.11.2, Table 12.11-2, Emission Factors for Secondary Lead Processing.
- [11] Sulfur dioxide (SO₂) emissions estimated assuming all sulfur from sulfuric acid converted to SO₂.
- [12] Emission factors from AP-42 Chapter 2.5, Table 2.5-1 "Emission Factors for Open Burning of Municipal Refuse," factors for Automobile Components

Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017

Products in Trailer No. 2 and No.3

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in Trailers [2]
				lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	(b) (3) (A), (b) (4)
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74 - <=76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethylethyl ester	927-07-1	>=44- <46%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethylethyl ester	927-07-1	>=74- <76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5 -<=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
Total (lbs)				69,300

Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017

Estimate Pounds of Material Lost in Fire
Destruction Efficiency [4] 93%

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	% Decomp to Fire Unburned [4]	% Decomp to Fire Burned [4]	% Burned from Original Product [5]	lb Decomp to Vapor	lb Decomp to Fire, Unburned	lb Decomp to Fire, Burned
	lbs					lbs	lbs	lbs
Lup 10	(b) (3) (A), (b) (4)	5%	6.65%	88.35%	0%	393.75	524	6,957.56
Lup 10M75		--	7%	93%	0%	--	2,094.75	27,830.25
Lup 11M45		--	7%	93%	0%	--	--	--
Lup 11M75		--	7%	93%	0%	--	--	--
Lup 188M75		5%	6.65%	88.35%	0%	630.00	837.90	11,132.10
Lup 221		--	7%	93%	0%	--	--	--
Lup 223M75S		--	7%	93%	0%	--	882.00	11,718.00
Lup 223S		--	7%	93%	0%	--	--	--
Lup 223V75		--	7%	93%	0%	--	--	--
Lup 225M60		--	7%	93%	0%	--	--	--
Lup 546M75		--	7%	93%	0%	--	441.00	5,859.00
Total	69,300					1,023.75	4,779.34	63,496.91

Notes:

[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".

[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

[3] According to Arkema, 5% as Lup 10 and LUP 188M75 was emitted as vapor prior to combustion. The remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).

[4] Per TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES, based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency is assumed. Therefore, for decomposed product Lup 188M75 remaining after vapor release, 7% unburned, and 93% of decomposed part is burned.

[5] Value excludes diluent (e.g., naphtha).

Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017

Input

Parameter	Value	Units
Diesel Oil Burned [1]	50	gal/event

[1] Total volume combusted (25 gallons from each trailer) based on email from Arkema, September 7, 2017.

Emission Factors and Emissions of Criteria Pollutants

Pollutant	Emission Factor [1] [2] (lb/Mgal)	Emissions (lb/event) (short tons/event)	
CO	5	0.25	1.3E-04
NO _x	24	1.20	6.0E-04
PM	3.3	0.17	8.3E-05
PM ₁₀	3.3	0.17	8.3E-05
PM _{2.5}	3.3	0.17	8.3E-05
SO ₂	71	3.55	1.8E-03
VOC	0.2	0.01	5.0E-06

Notes:

[1] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Tables 1.3-1 and 1.3-2 - No. 2 oil fired (1-01-005-01), (1-02-005-01), (1-03-005-01) for CO, NO_x, PM, PM₁₀, PM_{2.5}, and SO₂.

[2] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Table 1.3-3 - Industrial boilers, Distillate oil fired (1-02-005-01/02/03) for VOC.

Arkema Inc. - Crosby
Trailer No. 4-9 Products Decomposition Emissions
September 2, 2017

Trailer No. 4-9 Products Decomposition Emissions Summary

Emission Source	VOC Emissions
	(lb/event)
Products in Trailer No. 4 - 9 Decomposed to Air	1,329.46
Total Emissions	1,329.46

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Isobutane	75-28-5	56703	376.93
Isobutene	115-11-7	56704	121.29
OMS	68551-17-7	59275	831.24
Acetone	67-64-1	54020	502.17

Arkema Inc. - Crosby
Trailer No. 4-9 Products Decomposition Emissions
September 2, 2017

Summary of Emissions from Trailer No. 4-9 Products Decomposition [1]

Emission Source	Emissions (lb/event)					
	VOC	CO	NO _x	PM	PM ₁₀	PM _{2.5}
Decomposition to Vapor - Unburned	1,329.46	--	--	--	--	--
Total	1,329.46	0.00	0.00	0.00	0.00	0.00

1. Emissions from Decomposition to Vapor - Unburned

Product	Decomp Composition [2]	Vapor wt% [3]	Decomp to Vapor, Unburned - Total lbs	Decomp to Vapor, Unburned - Speciated lbs	Speciated VOC Emissions to Air lbs
Lup 11M45	Isobutane	12.46%	991.50	123.50	123.50
	Isobutene	4.01%		39.74	39.74
	Carbon Dioxide	12.57%		124.68	
	OMS	50%		494	493.60
	Acetone	16.59%		164.53	
	Methane	4.58%		45.45	
Lup 11M75	Isobutane	18.64%	1,359.39	253.43	253.43
	Isobutene	6.00%		81.55	81.55
	Carbon Dioxide	18.82%		255.86	
	OMS	24.84%		337.64	337.64
	Acetone	24.84%		337.64	
	Methane	6.86%		93.27	
Total VOC from Vapor (Unburned) to Air					1,329.46

Notes

[1] Based on information provided by Arkema, from Trailers 4-6, two trailers (5 and 8) had decomposition of products released to atmosphere on September 2, 2017 prior to the controlled combustion on September 3, 2017. The quantity decomposed is estimated to be 5% of the weight of Lup 11M45 and 11M75 which are used to represent the decomposition products to the vapor phase and emissions from the trailers to atmosphere on September 2, 2017. Emissions associated with the remaining product are represented in a separate emission event for the controlled combustion on September 3, 2017.

[2] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx". "OMS" stands for Organic Mineral Spirits.

[3] Calculated based on Lup 11M75 and 11M45 product decomposed, provided by Arkema in the file "in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

Arkema Inc. - Crosby
Trailer No. 4-9 Products Decomposition Emissions
September 2, 2017

Products in Trailer No. 4-9

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in Trailers [2]
				lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	(b) (3) (A), (b) (4)
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <= 76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1-dimethylethyl ester	927-07-1	>=44- <46%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1-dimethylethyl ester	927-07-1	>=74- <76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	
	Benzenemethanol, alpha.,alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5- <=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
Total (lbs)				221,716

Arkema Inc. - Crosby
Trailer No. 4-9 Products Decomposition Emissions
September 2, 2017

Estimate Pounds of Material Lost to Atmosphere

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	lb Decomp to Vapor
	lbs		lbs
Lup 10	(b) (3) (A), (b) (4)	--	--
Lup 10M75		--	--
Lup 11M45		5.00%	991.50
Lup 11M75		5.00%	1,359.39
Lup 188M75		--	--
Lup 221		--	--
Lup 223M75S		--	--
Lup 223S		--	--
Lup 223V75		--	--
Lup 225M60		--	--
Lup 546M75		--	--
Total	221,716		2,350.89

Notes:

[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".

[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

[3] Based on information provided by Arkema, from Trailers 4-6, two trailers (5 and 8) had decomposition of products released to atmosphere on September 2, 2017 prior to the controlled combustion on September 3, 2017. The quantity decomposed is estimated to be 5% of the weight of Lup 11M45 and 11M75 which are used to represent the decomposition products to the vapor phase and emissions from the trailers to atmosphere on September 2, 2017. Emissions associated with the remaining product are represented in a separate emission event for the controlled combustion on September 3, 2017.

Arkema Inc. - Crosby
Trailer No. 4-9 Combustion Emissions
September 3, 2017

Emissions Summary

Emission Source	Emissions (lb/event)								
	CO	NO _x	PM	PM ₁₀	PM _{2.5}	SO ₂	VOC	HF	Lead
Products in Trailer Nos. 4-9 Consumed in Fire	1,458.11	170.06	504.08	504.08	504.08	--	10,368.95	--	--
Trailer Consumed in Fire	2,906.25	93.00	2,325.00	2,325.00	2,325.00	--	744.00	--	--
Pallets Consumed in Fire	367.13	11.75	293.70	293.70	293.70	--	93.98	--	--
Containers Consumed in Fire	1,005.64	32.18	804.51	804.51	804.51	--	257.44	--	--
Refrigeration Unit in Fire	370.31	11.85	296.25	296.25	296.25	--	94.80	--	--
Refrigerant Consumed in Fire	--	--	--	--	--	--	--	19.68	--
Battery Consumed in Fire	--	--	32.24	32.24	32.24	58.73	--	--	10.92
Total Emissions	6,107.44	318.84	4,255.77	4,255.77	4,255.77	58.73	11,559.17	19.68	10.92

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Nonane	111-84-2	56703	2,268.66
Nonene	124-11-8	56704	746.08
Isobutane	75-28-5	55178	501.32
Isobutene	115-11-7	90100	161.31
n-propanol	71-23-8	51570	64.32
n-propanal	123-38-6	51721	20.72
sec-butanol	78-92-2	51580	219.22
sec-butanone	78-93-3	54065	71.09
OMS	68551-17-7	59275	2,608.73
Acetophenone	98-86-2	59861	969.34
2-Ethyl hexanol	104-76-7	51521	2,065.61
2-Ethyl hexanal	123-05-7	51601	672.55
Acetone	67-64-1	54020	1,569.03
Ethane	74-84-0	56550	24.48
Hydrofluoric Acid	7664-39-3	11162	19.68
Lead	7439-92-1	14319	10.92
CO	630-08-0	90300	6,107.44
NO _x	10102-44-0	70402	318.84
PM	--	10000	4,255.77
PM ₁₀	--	20000	4,255.77
PM _{2.5}	--	39999	4,255.77
Unclassified VOC [1]	--	500001	1,190.23

Note:

[1] Unclassified VOC includes VOC emissions from combustion products.

Summary of Emissions from Trailer No. 4 - No. 9

Emission Source	Emissions (lb/event)					
	VOC	CO	NO _x	PM	PM ₁₀	PM _{2.5}
Decomposition Products - Burned	15,168.05	1,428.11	170.02	504.03	504.08	504.08
Total	10,260.95	1,428.11	170.06	504.03	504.08	504.08

2. Emissions from Decomposition Products - Burned
VOC Emissions

Product	Original Composition [1]	Original wt% [1]	Decomposed Composition [1]	Decomposed wt% [2]	Decomp Products Release to Air Total [3]	Speciated Emissions to Air [3]	Destruction Efficiency 91% [3]				
							Product Burned - Total [3]	Product Burned - Speciated [3]	Heating Value [6]	Heat Input [6]	Speciated VOC Emissions to Air [3]
					lbs	lbs	lbs	lbs	lbm/Btu	MMBtu	lbs
Lap 10	Neodecaneperic acid, 1,1-dimethyl ester	>>99%	Nonane	3%	2,819	1,038.76	10,310.95	1,466.83	19,000	267.27	1,058.78
	Hydroperoxide, 1,1-dimethyl ester	<1%	Nonane	11%	347.59	347.59		4615.18	18,800	86.77	347.58
			Carbon Dioxide	21%	616.53	616.53		0	0.00	0.00	0.00
			CH ₄	7%	0.00	0.00		15,000	0.00	0.00	0.00
Lap 10K75	Neodecaneperic acid, 1,1-dimethyl ester	>>74 - <<76%	Nonane	29%	1,210	355.49	10,310.95	4,722.53	19,000	89.74	355.49
	Naphtha (petroleum), hydrotreated heavy	<26%	Nonane	10%	116.63	116.63		1,546.56	18,800	29.33	116.63
	Naphtha (petroleum), heavy alkylate	<26%	Carbon Dioxide	13%	162.64	162.64		2,160.80	0	0.00	0.00
	Hydroperoxide, 1,1-dimethyl ester	<0.3%	CH ₄	25%	361.06	361.06		3,995.84	15,000	60.00	361.06
Lap 11K45	Propaneperic acid, 1,1-dimethyl, 1,1-dimethyl ester	>>44 - <<46%	Isobutane	13%	1,319	164.25	10,310.95	2,297.09	19,567	84.99	164.25
	Naphtha (petroleum), hydrotreated heavy	<56%	Isobutane	9%	51.35	51.35		739.14	19,341	14.50	52.85
	Naphtha (petroleum), heavy alkylate	<56%	Carbon Dioxide	13%	165.69	165.69		2,515.06	0	0.00	0.00
			CH ₄	59%	656.49	656.49		9,186.93	15,000	137.71	656.49
Lap 11K75	Propaneperic acid, 1,1-dimethyl, 1,1-dimethyl ester	59%	Isobutane	19%	1,806	317.07	10,310.95	4,673.18	19,567	79.70	317.07
	Naphtha (petroleum), hydrotreated heavy	20%	Isobutane	6%	108.46	108.46		1,510.64	19,341	25.35	108.46
	Naphtha (petroleum), heavy alkylate	20%	Carbon Dioxide	19%	340.29	340.29		4,112.14	0	0.00	0.00
			CH ₄	25%	449.06	449.06		5,816.52	15,000	81.40	449.06
Lap 16KM75	Neodecaneperic acid, 1,1-methyl-1-phenylethyl ester	>>74 - <<75%	Nonane	23%	3,310	776.09	10,310.95	10,313.30	19,000	195.30	776.07
	Secundaneperic acid, alpha, alpha-dimethyl	>>5 - <<11%	Nonane	6%	256.37	256.37		3,496.03	18,800	64.63	256.37
	Decane, 1-methyl ester	>>5 - <<7%	Carbon Dioxide	11%	355.06	355.06		4,717.27	0	0.00	0.00
	Decane, 1-phenyl	<<5%	CH ₄	25%	824.09	824.09		15,548.61	15,000	164.53	824.09
Lap 121	Naphtha (petroleum), hydrotreated heavy	>>1 - <<25%	Acetone	29%	769.34	769.34	10,310.95	12,879.11	14,357	183.61	769.34
	Naphtha (petroleum), heavy alkylate	>>3 - <<25%	Methane	49%	129.48	129.48		1,715.59	21,509	56.99	129.48
	Propionic acid, diisopropyl ester	100%	n-propanal	44%	168	64.31		856.49	13,243	11.32	64.31
			n-propanal	14%	20.72	20.72		275.27	13,519	1.46	20.72
Lap 12KM75	Peroxydicarboxylic acid, bis(2-ethylhexyl) ester	>>75 - <<77%	Carbon Dioxide	31%	2,742	66.86	10,310.95	23,665.34	15,000	397.20	1,548.58
	Naphtha (petroleum), hydrotreated heavy	<25%	2-Ethyl hexanol	16%	562.53	562.53		6,676.79	15,000	100.15	562.53
	Naphtha (petroleum), heavy alkylate	<15%	Carbon Dioxide	25%	695.49	695.49		9,246.13	0	0.00	0.00
	Propionic acid, isopropyl ester	<0.2%									
Lap 12S5	Peroxydicarboxylic acid, bis(2-ethylhexyl) ester	>>99 - <<102%	2-Ethyl hexanol	56%	646	363.33	10,310.95	4,875.44	15,000	71.38	363.33
	Proprietary component	<0.3%	2-Ethyl hexanol	16%	188.24	188.24		1,571.13	15,000	21.57	188.24
	Peroxydicarboxylic acid, bis(2-ethylhexyl) ester	75.0%	Carbon Dioxide	23%	163.65	163.65		2,175.21	0	0.00	0.00
	Proprietary component	25.0%	2-Ethyl hexanol	16%	51.74	51.74		2,111.13	15,000	11.67	51.74
Lap 17S5M60	Peroxydicarboxylic acid, bis(1-methylpropyl) ester	>>59 - <<61%	n-Butanol	26%	777	119.22	10,310.95	2,917.44	14,206	61.17	119.22
	Naphtha (petroleum), hydrotreated heavy	<41%	n-Butanol	9%	71.09	71.09		944.42	13,543	17.39	71.09
	Naphtha (petroleum), heavy alkylate	<61%	Carbon Dioxide	21%	173.55	173.55		2,305.65	0	0.00	0.00
			CH ₄	40%	307.93	307.93		4,095.73	15,000	61.56	307.93
Lap 56KM75	Neodecaneperic acid, 1,1-dimethylpropyl ester	>>74 - <<75%	Nonane	26%	282	70.31	10,310.95	13,400.35	19,000	19.77	70.31
	Naphtha (petroleum), hydrotreated heavy	>>0 - <<25%	Nonane	9%	25.70	25.70		341.40	18,800	6.42	25.70
	Naphtha (petroleum), heavy alkylate	>>0 - <<25%	Carbon Dioxide	13%	35.82	35.82		475.07	0	0.00	0.00
	Hydroperoxide, 1,1-dimethylpropyl	<<0.1%	CH ₄	25%	70.13	70.13		931.73	15,000	13.58	70.13
Totals					24.88	24.88		332.27	20,826	6.64	24.88

NO_x, CO, and PM Emissions

Pollutant	Emission Factors lb/MMBtu	Emissions lb/event
NO _x [7]	3.2541	1.7805
CO [7]	3.5426	1,856.11
PM [8]	0.5	504.08

Notes

- (1) Decomposition ("Decomp") provided by Arkema in the file "Crosby Inv 062817 Trailers Rg Bldg Xist", "CME" sheet, 0.
- (2) Calculated based on Lap 11K45 and 11K75 product decomposition, provided by Arkema in the file "Crosby Inv 062817 Trailers Rg Bldg Xist".
- (3) Per TCEQ publication 95-360, 7.13, Revised February 2002, "PERMITTING REGULATORY GUIDANCE: EMISSIONS FROM AERIAL APPLICATIONS", 9.9.1.1, it is assumed that the destruction efficiency (DE) is 91%.
- (4) Product composition provided by Arkema in the file "Crosby Inventory 062817 Trailers Rg Bldg Xist".
- (5) Based on information provided by Arkema, 5% of Lap 11K45 and 11K75 vapor is atmospheric. Emissions from the September 2, 2017 emission event are not included in the emissions as included with the controlled conditions of the September 4, 2017 event. For the September 4, 2017 combustion, the remaining product decomposition efficiency (e.g., CH₄) and burned with a 93% DE (i.e., 7% of decomposition products and others is emitted to atmosphere and the remainder is converted to combustion products).
- (6) Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds: Estimation of Combustion Properties publication 95-360, 7.13, Revised February 2002, "PERMITTING REGULATORY GUIDANCE: EMISSIONS FROM AERIAL APPLICATIONS", 9.9.1.1, it is assumed that the destruction efficiency (DE) is 91%.
- (7) Based on AP 42, Table 3.3-1, heavily smoking flares: 274 lb/MMBtu in exhaust, calculated from combustion using F-factor method on a dry basis, assuming 5% methane gas stream limitation Emission Protocol for Petroleum Refineries, KTI International, May 2011, Table 6-9.
- (8) Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds: Estimation of Combustion Properties publication 95-360, 7.13, Revised February 2002, "PERMITTING REGULATORY GUIDANCE: EMISSIONS FROM AERIAL APPLICATIONS", 9.9.1.1, it is assumed that the destruction efficiency (DE) is 91%.

Summary of Emissions from Trailer Components Combustion

Emission Source	CO ₂	CO	HC	PM	PM ₁₀	PM _{2.5}
Combustion Emissions	1,788.74	4,448.33	148.79	3,719.46	3,719.46	3,719.46

Trailers		
Weight of Trailer (1)	15,500	pounds
# of Trailers	50%	
Weight of Trailer Burned	46,500	pounds
Pallets		
Weight of each Pallet (2)	445	pounds
# of Pallets in a Trailer (3)	23	
Burned	100%	
Weight of Pallets Burned	5,876	pounds
Containers		
Weight of a 55 Gal. Container (5)	1,130	pounds
Weight of 43.3 Gal. Containers	2,334	pounds
Capacity of a Trailer	3,200	gal
Number of 55 Gal Containers Impacted (5)	6,315	
Burned	100%	
Weight of Containers in a Trailer	16,290	pounds
Refrigeration Unit		
Weight of a Refrigeration Unit (6)	1,975	pounds
Burned	50%	
Weight of Refrigeration Unit Burned	987.5	pounds
Total Weight of Solid Combustibles	37,419	pounds

Refrigerant

Weight of Refrigerant [5]	16 pounds/ton			
Compositions [7]	CAS #	M. Wt.	Wt%	Emissions
		lb/lb-mol		lbs
1,1,1-Trichloroethane [7]	420-46-2	84.04	51%	49.92
Pentafluoroethane [7]	354-33-6	110.02	44%	42.24
1,1,1,2-Tetrafluoroethane [7]	811-97-2	104.03	4%	3.84
Emissions as Hydrogen Fluoride	7,664,393	20.01		19.58

Battery

Weight of Battery [8]	50	pounds/frailer		
Compositions [9]	CAS #	ML wt.	Wt%	Weight
		lb/lb-mol		lbs
Lead	7439-92-1	207.2	79%	110
Sulfuric acid	7664-93-8	98.08	3%	93

Emissions from Battery Burned

Pollutant	Emission Factor (10)	Emissions from Lead Burned	Emissions from Sulfuric Acid Burned (11)
	lb of pollutant per lb of metal processed	lbs	lbs
PM	3.07	22.24	—
Lead	1.04	20.76	—
CO ₂	—	—	58.73

NO_x, CO, and PM Emissions from Trailer Components Combustion

Pollutant	Emission Factor (12)	Emissions from Trailer Burning	Emissions from Pallets Burning	Emissions from Containers Burning	Emissions from Refrigeration Unit Burned	Total Emissions from Solid Combustibles
	lb/ton	lbs	lbs	lbs	lbs	lbs
CO ₂	19	274,950	35,380	237,440	93,600	1,190,230
NO _x	36	53,000	15,490	10,440	11,850	148,780
CO	1.25	2,520.25	107.11	1,603.88	373.13	4,604.37
PM	100	2,125.00	101.70	904.51	236.15	3,719.46

Notes:

- Per information provided by Arkema, the trailer is a 55' refrigerated trailer based on vendor information; typical weight of refrigerated trailer is 15,500 lb.
- Based on phone consultation between Arkema and Trinity Consultants on September 6, 2017, 50% of weight of trailer estimated to be combusted.
- According to dimensions of trailer provided by Arkema, typical pallet used in this type of trailer is 40" x 48" and weight is 445 lb.
- Provided by Arkema based on trailer inventory and product information.
- Provided by Arkema based on trailer inventory and product information; typical 55 lb product per container. Typical empty container weight based on vendor information.
- Weight of refrigeration unit and refrigerant based on vendor information for typical unit.
- Per ECHA Adhesive and solvent data sheet (12).
- Per KLM Trailer specifications.
- Per Lead acid Battery (13) normalized to total weight of battery for conservation.
- The battery is liquid or trailer burned in the fire and is represented as second lead processing in plant furnace. Particulate and re-emissions factors are selected based on AP-42 Chapter 12.1.2, Table 12.1.1-2, Emission Factors for Secondary Lead Processing.
- 1,1,1,2-tetrafluoroethane (HFC) emissions estimated assuming all HFCs from sulfuric acid converted to SO₂.
- Emission factors from AP-42 Chapter 2.5, Table 2.5-3, "Emission Factors for Open Burning of Municipal Refuse," Factors for Automobile Components.

Arkema Inc. - Crosby
Trailer No. 4-9 Combustion Emissions
September 3, 2017

Products in Trailer No. 4 to No.9

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in Trailers 4-9 [2]
				lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	(b) (3) (A), (b) (4)
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <=76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneperoxoic acid, 2,2-dimethyl-, 1,1- dimethylethyl ester	927-07-1	>=44- <46%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneperoxoic acid, 2,2-dimethyl-, 1,1- dimethylethyl ester	927-07-1	>=74- <76%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Neodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	
	Benzenemethanol, alpha,alpha-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5- <=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
Total (lbs)				221,716

Arkema Inc. - Crosby
Trailer No. 4-9 Combustion Emissions
September 3, 2017

Estimate Pounds of Material Lost in Fire
Destruction Efficiency [4]

93%

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	% Decomp to Fire - Unburned [4]	% Decomp to Fire - Burned [4]	% Burned from Original Product [5]	lb Decomp to Vapor	lb Decomp to Fire, Unburned	lb Decomp to Fire, Burned
	lbs					lbs	lbs	lbs
Lup 10	(b) (3) (A), (b) (4)	--	7%	93%	0%	--	2,839	37,712
Lup 10M75		--	7%	93%	0%	--	1,209.74	16,072
Lup 11M45		5.00%	6.65%	88.35%	0%	991.50	1,318.70	17,520
Lup 11M75		5.00%	6.65%	88.35%	0%	1,359.39	1,807.98	24,020
Lup 188M75		--	7%	93%	0%	--	3,310.37	43,981
Lup 221		--	7%	93%	0%	--	147.84	1,964
Lup 223M75S		--	7%	93%	0%	--	2,741.55	36,423
Lup 223S		--	7%	93%	0%	--	645.12	8,571
Lup 223V75		--	7%	93%	0%	--	282.24	3,750
Lup 225M60		--	7%	93%	0%	--	771.75	10,253
Lup 546M75		--	7%	93%	0%	--	281.75	3,743
Total	221,716					2,350.89	15,355.54	204,009

Notes:

[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".

[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

[3] Based on information provided by Arkema, 5% of Lup 11M45 and 11M75 vapor to atmosphere in the September 2, 2017 emission event prior to combustion. Emissions from the September 2, 2017 event are not included in the emissions associated with the controlled combustion of the September 3, 2017 event. For the September 3, 2017 combustion, the remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).

[4] Per TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES, based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency is assumed. Therefore, for decomposed product Lup 11M45 remaining after vapor release, 7% unburned, and 93% of decomposed part is burned.

[5] Value excludes diluent (e.g., naphtha).

APPENDIX C: MODEL INPUTS

AERMOD Source Inputs***Point Source Inputs***

Source ID	Description	UTM Easting (m)	UTM Northing (m)	Elevation (m)	Emission Rate (g/s)	Stack Height (m)	Stack Temperature (K)	Stack Velocity (m/s)	Stack Diameter (m)
EV2TRLR	Event 2 Trailer Vapors 8/31/17 02:00 to 02:30	305,065.9	3,314,744.5	15.54	1.0000	4.27	792.0	1.2	1.2
EV2FIRE	Event 2 Fire 8/31/17 02:30 to 04:00	305,060.6	3,314,749.7	15.54	1.0000	2.13	1273.2	5.4	8.2
EV3TRL2	Event 3 Trailer Vapors 9/1/17 17:00 to 17:30 hours	305,031.9	3,314,720.9	15.54	1.0000	4.27	792.0	1.2	1.2
EV3TRL3	Event 3 Trailer Vapors 9/1/17 17:00 to 17:30 hours	305,038.7	3,314,721.8	15.54	1.0000	4.27	792.0	1.2	1.2
EV3FIRE	Event 3 Fire 9/1/17 17:30-19:00 hours	305,034.2	3,314,730.1	15.54	1.0000	2.13	1273.2	5.4	13.4
EV4TRL5	Event 4 Trailer 5 Vapors 9/2/17 14:17 to 9/3/17 01:17 hours	304,927.0	3,314,945.0	15.86	1.0000	4.27	792.0	1.2	1.2
EV4TRL8	Event 4 Trailer 8 Vapors 9/2/17 14:17 to 9/3/17 01:17 hours	304,893.2	3,314,968.1	15.86	1.0000	4.27	792.0	1.2	1.2
EV5FIRE1	Event 5 Fire 9/3/17 17:40-19:40 hours Trailers 4 5 6	304,918.7	3,314,944.3	15.54	0.5000	2.13	1273.2	5.4	16
EV5FIRE2	Event 5 Fire 9/3/17 17:40-19:40 hours Trailer 7	304,907.9	3,314,959.2	15.54	0.1667	2.13	1273.2	5.4	8.2
EV5FIRE3	Event 5 Fire 9/3/17 17:40-19:40 hours Trailers 8 9	304,888.8	3,314,959.7	15.54	0.3333	2.13	1273.2	5.4	13.4

Area Source Inputs

Source ID	Description	UTM Easting (m)	UTM Northing (m)	Elevation (m)	Emission Rate (g/s/m²)	Release Height (m)	Initial Vertical Dimension (m)
WSTWTROV	Waste Water Overflow	304779.8	3314858.2	15.82	2.5E-05	1.55	0